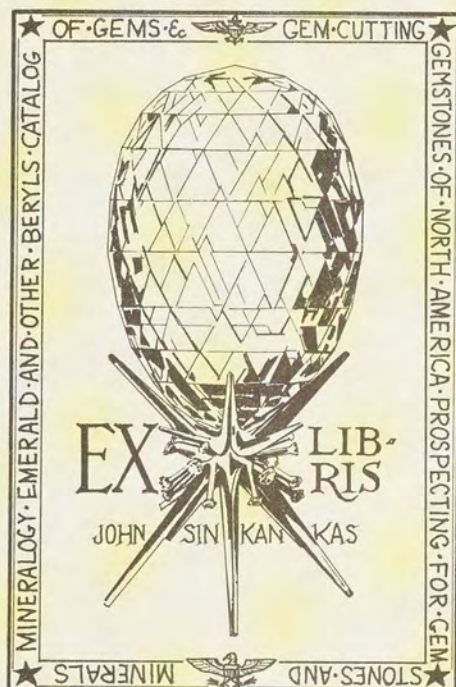


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ARTS, SCIENCES,
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MISCELLANEOUS LITERATURE;
Constructed on a PLAN,

BY WHICH
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THE THIRD EDITION, IN EIGHTEEN VOLUMES, GREATLY IMPROVED.

ILLUSTRATED WITH FIVE HUNDRED AND FORTY-TWO COPPERPLATES.

VOL. XII.

INDOCTI DISCANT, ET AMENT MRMINISSE PERITI.

EDINBURGH,
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MDCXCXVII.

1797

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Entered in Stationers Hall in Terms of the Act of Parliament.

Suppl. after p. 146

Minehead.	Names of Springs.	Countries in which they are found.	Contents and Quality of the Water.	Medical Virtues.	Minehead.
	Tarleton,	Lancashire in England.	Similar to Scarborough water.		
	Tewksbury,	Gloucestershire in England.	Similar to Acton.		
	Thetford,	Norfolk in England.	Fossile alkali, fixed air, and iron.	Purgative and diuretic.	
	Thoroton,	Nottinghamshire in England.	Similar to Orston.		
	Thursk,	Yorkshire in England.	Similar to Scarborough.		
	Tibshelf,	Derbyshire in England.	Iron dissolved in fixed air.	Similar to Spaw water.	
	Tilbury,	Essex in England.	Fossile alkali.	Diuretic and diaphoretic.	
	Tober Bony,	Near Dublin in Ireland.	Fossile alkali, earth, and bituminous oil.	Similar to Tilbury.	
	Tonstein,	Cologne in Germany.	Fossile alkali.	Similar to Seltzer, but more purgative.	
	Tralee,	Kerry in Ireland.	Similar to Castle Connel.		
	Tunbridge,	Kent in England.	Iron, some sea-salt, with a little selenites and calcareous earth.	An excellent chalybeate, useful in all diseases for which the Spaw is recommended.	
	Upminster,	Essex in England.	Sulphur, fossile alkali, and purging salt.	Purgative and diuretic.	
	Vahls,	Dauphiny in France.	Fossil alkali.	Diuretic and laxative.	
	Wardrew,	Northumberland.	Sulphur, earth, and sea-salt.	Similar to Harrowgate water.	
	Weatherstack,	Westmoreland in England.	Iron, sea-salt, and a small quantity of hepatic gas.	Purgative.	
	Wallenfrow,	Northamptonshire in England.	Similar to Islington water.		
	West Ashton,	Wiltshire in England.	Similar to Islington.		
	Westwood,	Derbyshire in England.	Green vitriol.	Similar to Shadwell. Used for washing ulcers of the legs.	
	Wexford,	Ireland.	Similar to Islington.		
	Whiteacre,	Lancashire in England.	Aerated iron and probably calcareous earth.	Somewhat astringent.	
	Wigglesworth,	Yorkshire in England.	Sulphur, earth, and common salt.	Emetic in the quantity of two quarts, and said to be cathartic in the quantity of three; a singular circumstance if true.	
	Wildungan,	Waldech in Germany.	Similar to the waters of Bath.	Useful in scorbutic and gouty diseases.	
	Witham,	Essex in England.	Aerated iron, and common salt.	Diuretic, alterative, and corroborant.	
	Wirksworth,	Derbyshire in England.	Sulphur, purging salt, and aerated iron.	Useful in scrofulous and cutaneous diseases.	
	Zahorovice,	Germany.	Similar to Nezdence water.	Much esteemed in scrofulous cases.	

MINEHEAD, a town of Somersetshire, 166 miles from London. It is an ancient borough, with a harbour in the Bristol channel, near Dunster castle, much frequented by passengers to and from Ireland. It was incorporated by Queen Elizabeth, with great privileges, on condition the corporation should keep the quay in repair; but its trade falling off, the quay was neglected, and they lost their privileges. A statute was obtained in the reign of King William, for recovering the port, and keeping it in repair, by which they were to have the profits of the quay and pier for 36 years, which have been computed at about 200 l. a year; and they were at the expence of new-building the quay. In pursuance of another act, confirming the former, a new head has been built to the quay, the beach cleared, &c. so that the biggest ship may enter, and ride safe in the harbour. The town contains about 500 houses, and 2000 souls. It was formerly

governed by a portreeve, and now by two constables chosen yearly at a court-leet held by the lord of the manor. Its chief trade is with Ireland, from whence about 40 vessels used to come hither in a year with wool; and about 4000 chaldrons of coals are yearly imported at this place. Watchet and Porlock, from South Wales, which lies directly opposite to it, about seven leagues over, the common breadth of this channel all the way from Holmes to the Land's End. Here are several rich merchants, who have some trade also to Virginia and the West Indies; and they correspond much with the merchants of Barnestaple and Bristol in their foreign commerce. Three or four thousand barrels of herrings, which come up the Severn in great shoals about Michaelmas, are caught, cured, and shipped off here every year, for the Mediterranean, &c. The market here is on Wednesday, and fair on Whitfun-Wednesday.

M I N E R A L O G Y,

IS that science which teaches us the properties of mineral bodies, and by which we learn how to characterise, distinguish, and class them into a proper order.

INTRODUCTION.

MINERALOGY seems to have been in a manner coeval with the world. Precious stones of various kinds appear to have been well known among the Jews and Egyptians in the time of Moses; and even the most rude and barbarous nations appear to have had some knowledge of the ores of different metals. As the science is nearly allied to chemistry, it is probable that the improvements both in chemistry and mineralogy have nearly kept pace with each other; and indeed it is but of late, since the principles of chemistry were well understood, that mineralogy has been advanced to any degree of perfection. The best way of studying mineralogy, therefore, is by applying chemistry to it; and not contenting ourselves merely with inspecting the outcrops of bodies, but decomposing them according to the rules of chemistry. This method has been brought to the greatest perfection by Mr Pott of Berlin, and after him by Mr Cronstedt of Sweden. To obtain this end, chemical experiments in the large way are without doubt necessary: but as a great deal of the mineral kingdom has already been examined in this manner, we do not need to repeat

all those experiments in their whole extent, unless some new and particular phenomena should discover themselves in those things we are examining; else the tediousness of those processes might discourage some from going farther, and take up much of the time of others that might be better employed. An easier way may therefore be adopted, which even for the most part is sufficient, and which, though made in miniature, is as scientific as the common manner of proceeding in the laboratories, since it imitates that, and is founded upon the same principles. This consists in making the experiments upon a piece of charcoal with the concentrated flame of a candle directed through a blow-pipe. The heat occasioned by this is very intense; and the mineral bodies may here be burnt, calcined, melted, and scorified, &c. as well as in any great works.

For a description of the blow-pipe, the method of using it, the proper fluxes to be employed, and the different subjects of examination to which that instrument is adapted, see the article *Blow-Pipe*, where all those particulars are concisely detailed. It may not be improper here, however, to resume those details at greater length; avoiding, at the same time, all unnecessary repetitions. After which we shall exhibit a scientific arrangement of the mineral kingdom, according to the most approved system.

PART. I. EXPERIMENTAL MINERALOGY; with a DESCRIPTION of the NECESSARY APPARATUS (A).

SECT. I. Of Experiments upon Earths and Stones.

WHEN any of these substances are to be tried, we must not begin immediately with the blow-pipe; but some preliminary experiments ought to go before, by which those in the fire may afterwards be directed. For instance, a stone is not always homogeneous, or of the same kind throughout, although it may appear to the eye to be so. A magnifying glass is therefore necessary to discover the heterogeneous particles, if there be any; and these ought to be separated, and every part tried by itself, that the effects of two different things, examined together, may not be attributed to one alone. This might happen with some of the finer micæ, which are now and then found mixed with small particles of quartz, scarcely to be perceived by the eye. The trapp (in German *schwartzstein*) is also sometimes mixed with very fine particles of felspar (*spatum scintillans*) or of calcareous spar, &c. After this experiment, the hardness of the stone in question must be tried with steel. The flint and garnets are commonly known to strike fire with steel; but there are also other stones, which, though very seldom, are

found so hard as likewise to strike fire. There is a kind of trapp of that hardness, in which no particles of felspar are to be seen. Coloured glasses resemble true gems; but as they are very soft in proportion to these, they are easily discovered by means of the file. The common quartz-crystals are harder than coloured glasses, but softer than the gems. The loadstone discovers the presence of iron, when it is not mixed in too small a quantity in the stone, and often before the stone is roasted. Some kinds of hæmatites, and particularly the cærulescens, greatly resemble some other iron ores; but this distinguishes itself from them by a red colour when pounded, the others giving a blackish powder, and so forth.

The management of the *Blow-pipe* has been described under that article; but a few particulars may be here recapitulated, or added.

The candle ought to be snuffed often, but so that the top of the wick may retain some fat in it, because the flame is not hot enough when the wick is almost burnt to ashes; but only the top must be snuffed off, because a low wick gives too small a flame. The blue flame is the hottest; this ought, therefore, to be forced

(A) From Engestrom's *Treatise on the Blow-Pipe*, and Magellan's *Description of Pocket-Laboratories*, &c. subjoined to the English Translation of Cronstedt's *Mineralogy*, 2d edit. in 2 vols. Dilly.

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forced out when a great heat is required, and only the point of the flame must be directed upon the subject which is to be assayed. M. Magellan recommends, as being most cleanly and convenient, that the candle be made of wax, and the wick should be thicker than ordinary. Its upper end must be bended towards the matter intended to be heated, and the stream of air must be directed along the surface of the bended part, so as not absolutely to touch it.

The piece of charcoal made use of in these experiments must not be of a disposition to crack. If this should happen, it must gradually be heated until it does not crack any more, before any assay is made upon it. If this be not attended to, but the assay made immediately with a strong flame, small pieces of it will split off in the face and eyes of the assayer, and often throw along with them the matter that was to be assayed. Charcoal which is too much burnt consumes too quick during the experiment, leaving small holes in it, wherein the matter to be tried may be lost; and charcoal that is burnt too little, catches flame from the candle, burning by itself like a piece of wood, which likewise hinders the process.

Of those things that are to be assayed, only a small piece must be broken off for that purpose, not bigger than that the flame of the candle may be able to act upon it at once, if required; which is sometimes necessary, as, when the matter requires to be made red hot throughout, the piece ought to be broken as thin as possible, at least the edges; the advantage of which is obvious, the fire having then more influence upon the subject, and the experiment being more quickly made.

Some of the mineral bodies are very difficult to be kept steady upon the charcoal during the experiment, before they are made red hot; because, as soon as the flame begins to act upon them, they split asunder with violence, and are dispersed. Such often are those which are of a soft consistence or a particular figure, and which preserve the same figure in however minute particles they are broken; for instance, the calcareous spar, the sparry gypsum, sparry fluor, white sparry lead-ore, the potters ore, the tessellated mock-lead or blende, &c. even all the common fluors which have no determinate figure. These not being so compact as common hard stones, when the flame is immediately urged upon them, the heat forces itself through and into their clefts or pores, and causes this violent expansion and dispersion. Many of the clays are likewise apt to crack in the fire, which may be for the most part ascribed to the humidity, of which they always retain a portion.

The only way of preventing this inconvenience is to heat the body as slowly as possible. It is best, first of all, to heat that place of the charcoal where the piece is intended to be put on; and afterwards lay it thereon: a little crackling will then ensue, but commonly of no great consequence. After that, the flame is to be blown very slowly towards it, in the beginning not directly upon, but somewhat above it, and so approaching nearer and nearer with the flame until it become red hot. This will do for the most part; but there are nevertheless some, which, notwithstanding all these precautions, it is almost impossible to keep on the charcoal. Thus the fluors are generally

the most difficult; and as one of their principal characters is discovered by their effects in the fire *per se*, they ought necessarily to be tried that way. To this purpose, it is best to make a little hole in the charcoal to put the fluor in, and then to put another piece of charcoal as a covering upon this, leaving only a small opening for the flame to enter. As this stone will nevertheless split and fly about, a larger piece thereof than is before-mentioned must be taken, in order to have at least something of it left.

But if the experiment is to be made upon a stone whose effects one does not want to see in the fire *per se*, but rather with fluxes, then a piece of it ought to be forced down into melted borax, when always some part of it will remain in the borax, notwithstanding the greatest part may sometimes fly away by cracking.

1. *Of substances to be tried in the fire per se.* As the stones undergo great alterations when exposed to the fire by themselves, whereby some of their characteristics, and often the most principal, are discovered, they ought first to be tried that way, observing what has been said before concerning the quantity of matter, direction of the fire, &c. The following are generally the results of this experiment.

Calcareous earth or stone, when it is pure, does not melt by itself, but becomes white and friable, so as to break freely between the fingers; and, if suffered to cool, and then mixed with water, it becomes hot, just like common quick-lime. As in these experiments only very small pieces are used, this last effect is best discovered by putting the proof on the outside of the hand, with a drop of water to it, when instantly a very quick heat is felt on the skin. When the calcareous substance is mixed with the vitriolic acid, as in gypsum, or with a clay, as in marle, it commonly melts by itself, yet more or less difficultly in proportion to the differences of the mixtures. Gypsum produces generally a white, and made a grey, glass or slag. When there is any iron in it, as a white iron ore, it becomes dark, and sometimes quite black, &c.

The *silices* never melt alone, but become generally more brittle after being burnt. Such of them as are coloured become colourless, and the sooner when it does not arise from any contained metal; for instance, the topazes, amethysts, &c. some of the precious stones, however, excepted: And such as are mixed with a quantity of iron grow dark in the fire, as some of the jaspers, &c.

Garnets melt always into a black slag, and sometimes so easily that they may be brought into a round globe upon the charcoal.

The *argillacea*, when pure, never melt, but become white and hard. The same effects follow when they are mixed with phlogiston. Thus the soap-rock is easily cut with the knife; but being burnt it cuts glass, and would strike fire with the steel, if as large a piece as is necessary for that purpose could be tried in this way. The soap-rocks are sometimes found of a dark brown and nearly black colour, but nevertheless become quite white in the fire like a piece of China ware. However, care must be taken not to urge the flame from the top of the wick, there being for the most part a footy smoke, which commonly will darken all that it touches; and, if this is not observed, a mistake in the experiment might easily happen. But if

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it is mixed with iron, as it is sometimes found, it does not so easily part with its dark colour. The argillaceæ when mixed with lime melt by themselves, as above-mentioned. When mixed with iron, as in the boles, they grow dark or black; and if the iron is not in too great a quantity, they melt alone into a dark slag; the same happens when they are mixed with iron and a little of the vitriolic acid, as in the common clay, &c.

Mica and *asbestos* become somewhat hard and brittle in the fire, and are more or less refractory, though they give some marks of fusibility.

The *fluors* discover one of their chief characteristics by giving a light like phosphorus in the dark, when they are slowly heated, but lose this property, as well as their colour, as soon as they are made red hot.—They commonly melt in the fire into a white opaque slag, though some of them not very easily.

Some sorts of the *zeolites* melt easily, and foam in the fire, sometimes nearly as much as borax, and become a frothy slag, &c.

A great many of those mineral bodies which are impregnated with iron, as the *boles*, and some of the white iron ores, &c. as well as some of the other iron ores, viz. the bloodstone, are not attracted by the loadstone before they have been thoroughly roasted, &c.

2. *Of substances heated with fluxes.* After the mineral bodies have been tried in the fire by themselves, they ought to be heated with fluxes to discover if they can be melted or not, and some other phenomena attending this operation. For this purpose, three different kinds of salts are used as fluxes, viz. sal soda, borax, and sal fusible microscmicum; (see the article *Blow-Pipe*).

The *sal soda* is, however, not much used in these small experiments, its effects upon the charcoal rendering it for the most part unfit for it; because, as soon as the flame begins to act upon it, it melts instantly, and is almost wholly absorbed by the charcoal. When this salt is employed to make any experiment, a very little quantity is wanted at once, viz. about the cubical contents of an eighth part of an inch, more or less. This is laid upon the charcoal, and the flame blown on it with the blow-pipe; but as this salt commonly is in form of a powder, it is necessary to go on very gently, that the force of the flame may not disperse the minute particles of the salt. As soon as it begins to melt, it runs along on the charcoal, almost like melted tallow; and when cold, it is a glassy matter of an opaque dull colour spread on the coal. The moment it is melted, the matter which is to be tried ought to be put into it, because otherwise the greatest part of the salt will be soaked into the charcoal, and too little of it left for the intended purpose. The flame ought then to be directed on the matter itself; and if the salt spreads too much about, leaving the proof almost alone, it may be brought to it again by blowing the flame on its extremities, and directing it towards the subject of the experiment. In the assays made with this salt, it is true, we may find whether the mineral bodies which are melted with it have been dissolved by it or not: but we cannot tell with any certitude whether this is done hastily and with force, or gently and slow; nor whe-

ther a less or a greater part of the matter has been dissolved: neither can it be well distinguished if the matter has imparted any weak tincture to the slag; because this salt always bubbles upon the charcoal during the experiment, nor is it clear when cool; so that scarcely any colour, except it be a very deep one, can be discovered, although it may sometimes be coloured by the matter that has been tried.

The following earths are entirely *soluble* in this flux with effervescence: Agate; chalcedony; carnelian; Turkey stone †, (*cos Turcica*); fluor mineralis †; onyx; opal; quartz; common flint; ponderous spar. The following are *divisible* in it with or without effervescence, but not entirely soluble: Amianthus; asbestos; basalt; chrysolite †; granate †; hornblende; jasper; marlstone; mica; the mineral of alum from Tolfa; petrosilex; aluminous slate and roof slate from Helsingia; emeralds; steatites; common flint; schoerl; talc; trapp; tripoli; tourmalin. And the following are neither fusible nor divisible in it: Diamond; hyacinth; ruby; sapphire; topaz.

The other two salts, viz. *borax* and the *sal microscmicum*, are very well adapted to these experiments, because they may by the flame be brought to a clear uncoloured and transparent glass; and as they have no attraction to the charcoal, they keep themselves always upon it in a round globular form. The sal fusible microscmicum is very scarce, and perhaps not to be met with in the shops; it is made of urine.

The following earths are soluble in borax, with more or less effervescence: Fluor mineralis †; marle; mica †; the mineral of alum from Tolfa; aluminous slate, and roof-slate from Helsingia †; ponderous spar; schoerl; talc †; tourmalin. And the following *without* effervescence: Agate; diamond; amianthus; asbestos; basalt; chalcedony; carnelian; chrysolite; *cos turcica*; granate; hyacinth *; jasper; lapis ponderosus; onyx; opal; petrosilex; quartz *; ruby; sapphire; common flint *; steatite; trapp; trippel, or tripoli; topaz; zeolite; hydrophanes.

In the microscmic salt, the following are soluble with more or less effervescence: Basalt †; turkey stone †; fluor mineralis †; marle; mica; the mineral of alum from Tolfa; schistus aluminaris, schistus tegularis from Helsingia †; schoerl; spathum ponderosum; tourmalin †; lapis ponderosus. And the following *without* visible effervescence: Agate; diamond; amianthus; asbestos; chalcedony; carnelian; chrysolite; granate; hyacinth; jasper; onyx ||; opal; petrosilex; quartz ||; ruby; sapphire; common flint ||; emerald; talc; topaz; trapp; trippel; zeolite; hornblende; hydrophanes; lithomarga; steatites.

Calcareous earth, ponderous spar, gypsum, and other additaments, often assist the solution, as well in the microscmic salt as in borax. To which it is necessary to add, that in order to observe the effervescence properly, the matter added to the flux should be in the form of a small particle rather than in fine powder; because in this last there is always air between the particles, which being afterwards driven off by the heat afford the appearance of a kind of effervescence (A).

The

(A) In the above lists, the articles marked † effervesce very little; those marked ‡ not at all; those marked * require a larger quantity of the flux and a longer continuance of heat than the rest; those marked || are more difficultly dissolved than the others.

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See *Chemistry*, n^o 905, 906.

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The quantity of those two salts required for an experiment is almost the same as the *sal soda*; but as the former are crystallised, and consequently include a great deal of water, particularly the borax, their bulk is considerably reduced when melted, and therefore a little more of them may be taken than the before-mentioned quantity.

Both those salts, especially the borax, when exposed to the flame of the blow-pipe, bubble very much and foam before they melt to a clear glass, which for the most part depends on the water they contain. And as this would hinder the assayer from making due observations on the phenomena of the experiment, the salt which is to be used must first be brought to a clear glass before it can serve as a flux; it must therefore be kept in the fire until it become so transparent that the cracks in the charcoal may be seen through it. This done, whatsoever is to be tried is put to it, and the fire continued.

Here it is to be observed, that for the assays made with any of these two fluxes on mineral bodies, no larger pieces must be taken than that altogether they may keep a globular form upon the charcoal; because it may then be better distinguished in what manner the flux acts upon the matter during the experiment. If this be not observed, the flux, communicating itself with every point of the surface of the mineral body, spreads all over it, and keeps the form of this last, which commonly is flat, and by that means hinders the operator observing all the phenomena which may happen. Besides, the flux being in too small a quantity in proportion to the body to be tried, will be too weak to act with all its force upon it. The best proportion therefore is about a third part of the mineral body to the flux; and as the quantity of the flux above mentioned makes a globe of a due size in regard to the greatest heat that is possible to procure in these experiments, so the size of the mineral body must be a third part less here than when it is to be tried in the fire by itself.

The *sal soda*, as has been already observed, is not of much use in these experiments; nor has it any particular qualities in preference to the two last mentioned salts, except that it dissolves the zeolites easier than they do.

The microcosmic salt shows almost the same effects in the fire as the borax, only differing from it in a very few circumstances; of which one of the principal is, that, when melted with manganese, it becomes of a crimson hue instead of a jacinth colour, which borax takes. This salt is, however, for its scarcity still very little in use, borax alone being that which is commonly employed. Whenever a mineral body is melted with any of these two last mentioned salts, in the manner already described, it is easily seen, whether it quickly dissolves; in which case an effervescence arises, that lasts till the whole be dissolved: whether the solution be slowly performed; in which case few and small bubbles only rise from the matter: or, whether it can be dissolved at all; because, if not, it is observed only to turn round in the flux, without the least bubble, and the edges look as sharp as they were before.

In order farther to illustrate what has been said about these experiments, we shall give a few examples of the effects of borax upon the mineral bodies.—The calca-

reous substances, and all those stones which contain any thing of lime in their composition, dissolve readily and with effervescence in the borax. The effervescence is the more violent the greater the portion of lime contained in the stone. This cause, however, is not the only one in the gypsum, because both the constituents of this do readily mix with the borax, and therefore a greater effervescence arises in melting gypsum with the borax than lime alone.—The *silices* do not dissolve; some few excepted which contain a quantity of iron.—The *argillaceæ*, when pure, are not acted upon by the borax: but when they are mixed with some heterogeneous bodies, they are dissolved, though very slowly: such are, for instance, the stone-marrow, the common clay, &c.

The *granates*, *zeolites*, and *trapp*, dissolve but slowly. The *fluors*, *asbestines*, and *micaceæ*, dissolve for the most part very easily; and so forth.—Some of these bodies melt to a colourless transparent glass with the borax; for instance, the calcareous substances, when pure, the fluors, some of the zeolites, &c. Others tinge the borax with a green transparent colour, viz. the granates, trapp, some of the argillaceæ, and some of the micaceæ and albitinæ. This green has its origin partly from a small portion of iron which the granates particularly contain, and partly from phlogiston.

Borax can only dissolve a certain quantity of the mineral body proportional to its own. Of the calcareous kind it dissolves a vast quantity; but turns at last, when too much has been added, from a clear transparent to a white opaque slag. When the quantity of the calcareous matter exceeds but little in proportion, the glass looks very clear as long as it remains hot: but as soon as it begins to cool, a white half opaque cloud is seen to arise from the bottom, which spreads over the third, half, or more of the glass globe, in proportion to the quantity of calcareous matter; but the glass or slag is nevertheless thinning, and of a glassy texture when broken. If more of this matter be added, the cloud rises quicker and is more opaque, and so by degrees till the slag becomes quite milk white. It is then no more of a shining, but rather dry appearance, on the surface; is very brittle, and of a grained texture when broken.

SECT. II. Of Experiments upon Metals and Ores.

WHAT has been hitherto said relates only to the *stones* and *earths*: We shall now proceed to describe the manner of examining *metals* and *ores*. An exact knowledge and nicety of procedure are so much the more necessary here, as the metals are often so disguised in their ores, as to be very difficultly known by their external appearance, and liable sometimes to be mistaken one for the other: Some of the cobalt ores, for instance, resemble much the *pyrites arsenicalis*; there are also some iron and lead ores, which are nearly like one another, &c.

As the ores generally consist of metals mineralised with sulphur or arsenic, or sometimes both together, they ought first to be exposed to the fire by themselves, in order not only to determine with which of these they are mineralised, but also to set them free from those volatile mineralising bodies: this serves instead of calcination, by which they are prepared for further assays.

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Here it must be repeated, that whenever any metal or fusible ore is to be tried, a little concavity must be made in that place of the charcoal where the matter is to be put; because, as soon as it is melted, it forms itself into a globular figure, and might then roll from the charcoal, if its surface was plain; but when borax is put to it, this inconvenience is not so much to be feared.

Whenever an ore is to be tried, a small bit being broke off for the purpose, it is laid upon the charcoal, and the flame blown on it slowly. Then the sulphur or arsenic begins to part from it in form of smoke: these are easily distinguished from one another by their smell; that of sulphur being sufficiently known, and the arsenic smelling like garlick. The flame ought to be blown very gently as long as any smoke is seen to part from the ore; but after that, the heat must be augmented by degrees, in order to make the calcination as perfect as possible. If the heat be applied very strongly from the beginning upon an ore that contains much sulphur or arsenic, the ore will presently melt, and yet lose very little of its mineralising bodies, by that means rendering the calcination very imperfect. It is, however, impossible to calcine the ores in this manner to the utmost perfection, which is easily seen in the following instance, *viz.* in melting down a calcined potter's ore with borax, it will be found to bubble upon the coal, which depends on the sulphur which is still left, the vitriolic acid of this uniting with the borax; and causing this motion. However, lead in its metallic form, melted in this manner, bubbles upon the charcoal, if any sulphur remains in it. But as the lead, as well as some of the other metals, may raise bubbles upon the charcoal, although they are quite free from the sulphur, only by the flames being forced too violently on it, these phenomena ought not to be confounded with each other.

The ores being thus calcined, the metals contained in them may be discovered, either by being melted alone or with fluxes; when they show themselves either in their pure metallic state, or by tinging the slag with a colour peculiar to each of them. In these experiments it is not to be expected that the quantity of metal contained in the ore should be exactly determined; this must be done in larger laboratories. This cannot, however, be looked upon as any defect, since it is sufficient for a mineralogist only to find out what sort of metal is contained in the ore. There is another circumstance, which is a more real defect in the miniature laboratories, which is, that some ores are not at all capable of being tried by so small an apparatus; for instance, the gold ore called *pyrites aureus*, which consists of gold, iron, and sulphur. The greatest quantity of gold which this ore contains is about one ounce, or one ounce and an half, out of 100 pounds of the ore, the rest being iron and sulphur: and as only a very small bit is allowed for these experiments, the gold contained therein can hardly be discerned by the eye, even if it could be extracted; but it goes along with the iron in the slag, this last metal being in so large a quantity in proportion to the other, and both of them having an attraction for each other.

The blendes and black-jacks, which are mineral zinc ores, containing zinc, sulphur, and iron, cannot be tried this way, because they cannot be perfectly

calcined, and besides the zinc flies off when the iron scorifies. Neither can those blendes, which contain silver or gold mineralised with them, be tried in this manner, which is particularly owing to the imperfect calcination. Nor are the quicksilver ores fit for these experiments; the volatility of that semimetal making it impossible to bring it out of the poorer sort of ores; and the rich ores, which sweat out the quicksilver when kept close in the hand, not wanting any of these assays, &c. Those ores ought to be assayed in larger quantities, and even with such other methods as cannot be applied upon a piece of charcoal.

Some of the rich silver ores are easily tried: for instance, *minera argenti vitrea*, commonly called *silver-glass*, which consists only of silver and sulphur. When this ore is exposed to the flame, it melts instantly, and the sulphur goes away in fume, leaving the silver pure upon the charcoal in a globular form. If this silver should happen to be of a dirty appearance, which often is the case, then it must be melted anew with a very little borax; and after it has been kept in fusion for a minute or two, so as to be perfectly melted and red-hot, the proof is suffered to cool: it may then be taken off the coal; and being laid upon the steel-plate†, the silver is separated from the slag by one or two strokes of the hammer†. Here the use of the article † See the article Blow-Pipe, and Plate XCIX. brass ring† is manifest; for this ought first to be placed upon the plate, to hinder the proof from flying off by the violence of the stroke, which otherwise would happen. The silver is then found inclosed in the slag of a globular form, and quite shining, as if it was polished. When a large quantity of silver is contained in a lead ore, *viz.* in a potter's ore, it can likewise be discovered through the use of the blow-pipe, of which more will be mentioned hereafter.

Tin may be melted out of the pure tin ores in its metallic state. Some of these ores melt very easily, and yield their metal in quantity, if only exposed to the fire by themselves: but others are more refractory; and as these melt very slowly, the tin, which sweats out in form of very small globules, is instantly burnt to ashes before these globules have time to unite in order to compose a larger globe, which, might be seen by the eye, and not so soon destroyed by the fire; it is therefore necessary to add a little borax to these from the beginning, and then to blow the flame violently at the proof. The borax does here preserve the metal from being too soon calcined, and even contributes to the reader collecting of the small metallic particles, which soon are seen to form themselves into a globule of metallic tin at the bottom of the whole mass, nearest to the charcoal. As soon as so much of the metallic tin is produced as is sufficient to convince the operator of its presence, the fire ought to be discontinued, though the whole of the ore be not yet melted; because the whole of this kind of ore can be seldom or never reduced into metal by means of these experiments, a great proportion being always calcined: and if the fire is continued too long, perhaps even the metal already reduced may likewise be burnt to ashes; for the tin is very soon deprived of its metallic state by the fire.

Most part of the lead ores may be reduced to a metallic state upon the charcoal. The *minera plumbi californica*, which are pure, are easily melted into lead; but

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but such of them as are mixed with an *ochra ferri*, or any kind of earth, as clay, lime, &c. yield very little of lead. and even nothing at all, if the heterogenea are combined in any large quantity: this happens even with the *minera plumbi calciformis arsenico mixta*. These therefore are not to be tried but in larger laboratories. However, every mineral body suspected to contain any metallic substance may be tried by the blow-pipe, so as to give sufficient proofs whether it contain any or not, by its effects being different from those of the stones or earths, &c.

The *minera plumbi mineralisate* leave the lead in a metallic form, if not too large a quantity of iron is mixed with it. For example, when a tessellated or steel-grained lead ore is exposed to the flame, its sulphur, and even the arsenic if there be any, begins to fume, and the ore itself immediately to melt into a globular form; the rest of the sulphur continues then to fly off, if the flame be blown slowly upon the mass; but, on the contrary, very little of the sulphur will go off, if the flame be forced violently on it: in this case, it rather happens that the lead itself crackles and dissipates, throwing about very minute metallic particles. The sulphur being driven out as much as possible, which is known by finding no sulphureous vapour in smelling at the proof, the whole is suffered to cool, and then a globule of metallic lead will be left upon the coal. If any iron is contained in the lead-ore, the lead, which is melted out of it, is not of a metallic shining, but rather of a black and uneven surface: a little borax must in this case be melted with it, and as soon as no bubble is seen to rise any longer from the metal into the borax, the fire must be discontinued: when the mass is grown cold, the iron will be found scorified with the borax, and the lead left pure and of a shining colour.

Borax does not scorify the lead in these small experiments when it is pure: if the flame is forced with a violence on it, a bubbling will ensue, resembling that which is observed when borax dissolves a body melted with it; but when the fire ceases, the slag will be perfectly clear and transparent, and a quantity of very minute particles of lead will be seen spread about the borax, which have been torn off from the mass during the bubbling.

If such a lead ore is rich in silver, this last metal may likewise be discovered by this experiment; because as the lead is volatile, it may be forced off, and the silver remain. To effect this, the lead, which is melted out of the ore, must be kept in constant fusion with a slow heat, that it may be consumed. This end will be sooner obtained, and the lead part quicker, if during the fusion the wind through the blow-pipe be directed immediately, though not forcibly, upon the melted mass itself, until it begin to cool; at which time the fire must be directed on it again. The lead, which is already in a volatilising state, will by this artifice be driven out in form of a subtil smoke; and by thus continuing by turns to melt the mass, and then to blow off the lead, as has been said, until no smoke is any longer perceived, the silver will at last be obtained pure. The same observation holds good here also, which was made about the gold, that, as none but very little bits of ores can be employed in these experiments, it will be difficult to extract the silver

out of a poor ore; for some part of it will fly off with the lead, and what might be left is too small to be discerned by the eye. The silver, which by this means is obtained, is easily distinguished from lead by the following external marks, viz. that it must be red-hot before it can be melted: it cools sooner than lead: it has a silver colour; that is to say, brighter and whiter than lead: and is harder under the hammer.

The *minera cupri calciformes* (at least some of them), when not mixed with too much stone or earth, are easily reduced to copper with any flux; if the copper is found not to have its natural bright colour, it must be melted with a little borax, which purifies it. Some of these ores do not all discover their metal if not immediately melted with borax; the heterogenea contained in them hindering the fusion before there are scorified by the flux.

The grey copper ores, which only consist of copper and sulphur, are tried almost in the same manner as above mentioned. Being exposed to the flame by themselves, they will be found instantly to melt, and part of their sulphur to go off. The copper may afterwards be obtained in two ways: the one, by keeping the proof in fusion for about a minute, and afterwards suffering it to cool; when it will be found to have a dark and uneven appearance externally, but which after being broken discovers the metallic copper of a globular form in its centre, surrounded with a regulus, which still contains some sulphur and a portion of the metal: the other, by being melted with borax, which last way sometimes makes the metal appear sooner.

The *minera cupri pyritacea*, containing copper, sulphur, and iron, may be tried with the blow-pipe if they are not too poor. In these experiments the ore ought to be calcined, and after that the iron scorified. For this purpose a bit of the ore must be exposed to a slow flame, that as much of the sulphur as possible may part from it before it is melted, because the ore commonly melts very soon, and then the sulphur is more difficultly driven off. After being melted, it must be kept in fusion with a strong fire for about a minute, that a great part of the iron may be calcined; and after that, some borax must be added, which scorifies the iron, and turns with it to a black slag. If the ore is very rich, metallic copper will be had in the slag after the scorification. If the ore be of a moderate richness, the copper will still retain a little sulphur, and sometimes iron: the product will therefore be brittle, and must with great caution be separated from the slag, that it may not break into pieces; and if this product is afterwards treated in the same manner as before said, in speaking of the grey copper-ores, the metal will soon be produced. But if the ore is poor, the product after the first scorification must be brought into fusion, and afterwards melted with some fresh borax, in order to calcine and scorify the remaining portion of iron; after which it may be treated as mentioned in the preceding paragraph. The copper will in this last case be found in a very small globule.

The copper is not very easily scorified with this apparatus, when it is melted together with borax, unless it has first been exposed to the fire by itself for a while in order to be calcined. When only a little of this metal is dissolved, it instantly tinges the slag of a reddish

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dish brown colour, and mostly opaque; but as soon as this slag is kept in fusion for a little while, it becomes quite green and transparent: and thus the presence of the copper may be discovered by the colour, when it is concealed in heterogeneous bodies, so as not to be discovered by any other experiment.

If metallic copper is melted with borax by a slow fire, and only for a very little time, the glass or slag becomes of a fine transparent blue or violet colour, inclining more or less to the green: but this colour is not properly owing to the copper, but it may rather be to its phlogiston; because the same colour is to be had in the same manner from iron; and these glasses, which are coloured with either of those two metals, soon lose their colour if exposed to a strong fire, in which they become quite clear and colourless. Besides, if this glass, tinged blue with the copper, is again melted with more of this metal, it becomes of a good green colour, which for a long time keeps unchanged in the fire.

The iron ores, when pure, can never be melted *per se*, by the means of the blow-pipe alone; nor do they yield their metal when melted with fluxes; because they require too strong a heat to be brought into fusion; and as both the ore and the metal itself very soon lose their phlogiston in the fire, and cannot be supplied with a sufficient quantity from the charcoal, so likewise they are very soon calcined in the fire. This easy calcination is also the reason why the fluxes, for instance borax, readily scorify this ore, and even the metal itself. The iron loses its phlogiston in the fire sooner than the copper, and is therefore more easily scorified.

The iron is, however, discovered without much difficulty, although it were mixed but in a very small quantity with heterogeneous bodies. The ore, or those bodies which contain any large quantity of the metal, are all attracted by the loadstone, some without any previous calcination, and others without having been roasted. When a clay is mixed with a little iron, it commonly melts by itself in the fire; but if this metal is contained in a limestone, it does not promote the fusion, but gives the stone a dark and sometimes a deep black colour, which always is the character of iron. A *minera ferri calciformis pura crystallifera*, is commonly of a red colour: This being exposed to the flame, becomes quite black; and is then readily attracted by the loadstone, which it was not before. Besides these signs, the iron discovers itself, by tinging the slag of a green transparent colour, inclining to brown, when only a little of the metal is scorified; but as soon as any larger quantity thereof is dissolved in the slag, this becomes first a blackish brown, and afterwards quite black and opaque.

Bismuth is known by its communicating a yellowish brown colour to borax; and arsenic by its volatility and garlick smell. Antimony, both in form of regulus and ore, is wholly volatile in the fire when it is not mixed with any other metal except arsenic; and is known by its particular smell, easier to be distinguished when once known than described. When the ore of antimony is melted upon the charcoal, it bubbles constantly during its volatilising.

Zinc ores are not easily tried upon the coal; but

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the regulus of zinc exposed to the fire upon the charcoal burns with a beautiful blue flame, and forms itself almost instantly into white flowers, which are the common flowers of zinc.

Cobalt is particularly remarkable for giving to the glass a blue colour, which is the zaffre or smalt. To produce this, a piece of cobalt ore must be calcined in the fire, and afterwards melted with borax. As soon as the glass, during the fusion, from being clear, seems to grow opaque, it is a sign that it is already tinged a little; the fire is then to be discontinued, and the operator must take hold, with the nippers, of a little of the glass, whilst yet hot, and draw it out slowly in the beginning, but afterwards very quick, before it cools, whereby a thread of the coloured glass is procured, more or less thick, wherein the colour may easier be seen than in a globular form. This thread melts easily, if only put in the flame of the candle without the help of the blow-pipe.—If this glass be melted again with more of the cobalt, and kept in fusion for a while, the colour becomes very deep; and thus the colour may be altered at pleasure.

When the cobalt ore is pure, or at least contains but little iron, a cobalt regulus is almost instantly produced in the borax during the fusion; but when it is mixed with a quantity of iron, this last metal ought first to be separated, which is easily performed since it scorifies sooner than the cobalt; therefore, as long as the slag retains any brown or black colour, it must be separated, and melted again with fresh borax, until it shows the blue colour.

Nickel is very seldom to be had; and as its ores are seldom free from mixtures of other metals, it is very difficultly tried with the blow-pipe. However, when this semimetal is mixed with iron and cobalt, it is easily freed from these heterogeneous metals, and reduced to a pure nickel regulus by means of scorification with borax, because both the iron and cobalt sooner scorify than the nickel. The regulus of nickel itself is of a green colour when calcined: it requires a pretty strong fire before it melts, and tinges the borax with a hyacinth colour. Manganese gives the same colour to borax; but its other qualities are quite different, so as not to be confounded with the nickel.

By means of the foregoing explanations, and those given under the article *Blow-Pipe*, any gentleman, who is a lover of this science, will be able, in an easy manner, to amuse himself in discovering the properties of those works of nature, with which the mineral kingdom furnishes us; or more usefully to employ himself by finding out what sorts of stones, earths, ores, &c. there are on his estate, and to what economical purposes they may be employed. The scientific mineralist may, by examining into the properties and effects of the mineral bodies, discover the natural relation these bodies stand in to each other, and thereby furnish himself with materials for establishing a mineral system, founded on such principles as Nature herself has laid down in them; and this in his own study, without being forced to have recourse to great laboratories, crucibles, furnaces, &c. which is attended with much trouble, and is the reason why so few can have an opportunity of gratifying their desire of knowledge in this

this part of natural history. Farther improvements of this apparatus may still be made by those who choose to bestow their attention upon it.

A great number of fluxes might, perhaps, be found out, whose effects might be different from those already in use, whereby more distinct characters of those mineral bodies might be discovered, which now either show ambiguous ones, or which it is almost impossible to try exactly with the blow-pipe. Instead of the *sal soda*, some other salt might be discovered better adapted to these experiments. But it is very necessary not to make use of any other fluxes on the charcoal than such as have no attraction to it: if they, at the same time, be clear and transparent, when melted, as the borax and the *sal fusibile microscopicum*, it is still better: however, the transparency and opacity are of no great consequence, if a substance be essayed only in order to discover its fusibility, without any attention to its colour; in which case, some metallic slag, perhaps, might be useful.

When such ores are to be reduced whose metals are very easily calcined, as tin, zinc, &c. it might perhaps be of service to add some phlogistic body, such as hard resin, since the charcoal cannot afford enough of it in the open fire of these essays. The manner of melting the volatile metals out of their ores *per descensum* might also, perhaps, be imitated: for instance, a hole might be made in the charcoal, wide above and very narrow at the bottom; a little piece of the ore being then laid at the upper end of the hole, and covered with some very small pieces of the charcoal, the flame must be directed on the top: the metal might, perhaps, by this method, run into the hole below, concealed from the violence of the fire, particularly if the ore is very fusible, &c.

The use of the apparatus above referred to, and which may be called a *pocket laboratory* (as the whole admits of being easily packed into a small case), is chiefly calculated for a travelling mineralist. But a person who always resides at one and the same place, may by some alteration make it more commodious to himself, and avoid the trouble of blowing with the mouth. For this purpose he may have the blow-pipe go through a hole in a table, and fixed underneath to a small pair of bellows with double bottoms, such as some of the glass-blowers use, and then nothing more is required than to move the bellows with the feet during the experiment; but in this case a lamp may be used instead of a candle. This method would be attended with a still greater advantage, if there were many such parts as *c*, fig. 13. the openings of which were of different dimensions: those parts might by means of a screw be fastened to the main body of the blow-pipe, and taken away at pleasure. The advantage of having these nozzles of different capacities at their ends, would be that of exciting a stronger or weaker heat as occasion might require. It would only be necessary to observe, that in proportion as the opening or nozzle of the pipe is enlarged, the quantity of the flame must be augmented by a thicker wick in the lamp, and the force of blowing increased by means of weights laid on the bellows; a much intenser heat would thus be produced by a pipe of a considerable opening at the end, by which the expe-

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riments must undoubtedly be carried farther than the common blow-pipe.

A traveller, who has seldom an opportunity of carrying many things along with him, may very well be contented with this laboratory and its apparatus, which are sufficient for most part of such experiments as can be made on a journey. There are, however, other things very useful to have at hand on a journey, which ought to make a separate part of a portable laboratory, if the manner of travelling does not oppose it: this consists of a little box including the different acids, and one or two matraffes, in order to try the mineral bodies in liquid menstrua if required.

These acids are, the acid of nitre, of vitriol, and of common salt. Most of the stones and earths are attacked, at least in some degree, by the acids; but the calcareous are the easiest of all to be dissolved by them, which is accounted for by their calcareous properties. The acid of nitre is that which is most used in these experiments; it dissolves the limestone, when pure, perfectly, with a violent effervescence, and the solution becomes clear: when the limestone enters into some other body, it is nevertheless discovered by this acid, through a greater or less effervescence in proportion to the quantity of the calcareous particles, unless there are so few as to be almost concealed from the acid by the heterogeneous ones. In this manner a calcareous body, which sometimes nearly resembles a siliceous or argillaceous one, may be known from these latter, without the help of the blow-pipe, only by pouring one or two drops of this acid upon the subject; which is very convenient when there is no opportunity nor time of using this instrument.

The gypsa, which consist of lime and the vitriolic acid, are not in the least attacked by the acid of nitre, if they contain a sufficient quantity of their own acid; because the vitriolic acid has a stronger attraction to the lime than the acid of nitre: but if the calcareous substance is not perfectly saturated with the acid of vitriol, then an effervescence arises with the acid of nitre, more or less in proportion to the want of the vitriolic acid. These circumstances are often very essential in distinguishing the *calcareae* and *gypsa* from one another.

The acid of nitre is likewise necessary in trying the zeolites, of which some species have the singular effect to dissolve with effervescence in the above mentioned acid; and within a quarter of an hour, or even sometimes not until several hours after, to change the whole solution into a clear jelly, of so firm a consistence, that the glass wherein it is contained may be reversed without its falling out.

If any mineral body is tried in this menstruum, and only a small quantity is suspected to be dissolved, though it was impossible to distinguish it with the eye during the solution, it can be easily discovered by adding to it *ad saturitatem* a clear solution of the alkali, when the dissolved part will be precipitated, and fall to the bottom. For this purpose the *sal soda* may be very useful.

The acid of nitre will suffice for making experiments upon stones and earths; but if the experiments are to be extended to the metals, the other two acids are also necessary.

Another instrument is likewise necessary to a
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complete Pocket-Laboratory, viz. a washing-trough (fig. 21.), in which the mineral bodies, and particularly the ores, may be separated from each other, and from the adherent rock, by means of water. This trough is very common in laboratories, and is used of different sizes; but here only one is required of a moderate size, such as 12 inches and a half long, three inches broad at the one end and one inch and a half at the other end, sloping down from the sides and the broad end to the bottom, where it is three quarters of an inch deep. It may, however, be made of much smaller dimensions. It is commonly made of wood, which ought to be chosen smooth, hard, and compact, wherein are no pores in which the minute grains of the pounded matter may conceal themselves. It is to be observed, that if any such matter is to be washed as is suspected to contain some native metal, such as silver or gold, a trough should be procured for this purpose of a very shallow slope; because the minute particles of the native metal have then more power to assemble together at the broad end, and separate from the other matter.

The management of this trough, or the manner of washing, consists in this: That when the matter is mixed with about three or four times its quantity of water in the trough, this is kept very loose between two fingers of the left hand, and some light strokes given on its broad end with the right, that it may move backwards and forwards; by which means the heaviest particles assemble at the broad and lower end, from which the lighter ones are to be separated by inclining the trough and pouring a little water on them. By repeating this process, all such particles as are of the same gravity may be collected together, and separated from those of different gravity, provided they were before equally pounded: though such as are of a clayey nature, are often very difficult to separate from the rest, which, however, is of no great consequence to a skilful and experienced washer. The washing process is very necessary, as there are often rich ores, and even native metals, found concealed in earths and sand in such minute particles as not to be discovered by any other means.

SECT. III. Description of an Improved Portable Laboratory for assaying Minerals.

THE chief pieces and implements of the portable laboratories are represented in Plate XCIX. at *Blow-Pipe*, and in Plate CCCXIII. annexed to the present article.

I. The first contains those belonging to the *Dry Laboratory*, so called on account of its containing whatever is required to try all kinds of fossils in the dry way by fire, without any of the humid menstrua. They are made to pack in a box of the size of an octavo book, lined with green velvet, and covered with black fish-skin; the inside divided into different compartments, suited to the size, form, and number of the implements it is to contain. Of these the principal are described under *Blow-Pipe*. We must here, however, add the following remarks and alterations of that instrument by Mr Magellan.

Plate
CCCXIII.

D and Q (fig. 13.) are the two pieces that form the blow-pipe, which is here represented entire. This very useful instrument has been considerably improved

of late in England. The mouth-piece *aa* is made of ivory, to avoid the disagreeable sensation of having a piece of metal a long time between the teeth and lips, which, if not of silver or gold, may be very noxious to the operator; a circumstance that has been hardly noticed before.

1. If the mouth-piece *aa* be made of a round form, it cannot be held for any length of time between the teeth and lips, to blow through it, without straining the muscles of the mouth, which produces a painful sensation. It must, therefore, have such an external figure, as to adapt itself accurately to the lateral angles of the lips, having a flattish oval form externally, with two opposite corners to fit those internal angles of the mouth, when it is held between the lips, as may be seen in that represented in the figure.

2. The small globe *bb* is hollow, for receiving the moisture of the breath; and must be composed of two hemispheres, exactly screwing into one another in *bb*; the male-screw is to be in the lower part, and soldered on the crooked part *Q* of the tube *QD*, at such a distance, that the inside end of the crooked tube be even with the edge of the hemisphere, as represented by the pointed lines in the figure. But the upper hemisphere is to be soldered at the end of the straight tube *D*. By these means, the moisture arising from the breath falls into the hollow of the lower hemisphere, where it is collected round the upper inside end of the crooked part *Q* of the blow-pipe, without being apt to fall into it.

3. The small nozzles, or hollow conical tubes, advised by Messrs Engestrom, Bergman, and others, are wrong in the principle; because the wind that passes from the mouth through such long cones loses its velocity by the lateral friction, as happens in hydraulic spouts; which, when formed in this manner, do never throw the fluid so far as when the fluid passes through a hole of the same diameter, made in a thin plate of a little metallic cap that screws at the end of the large pipe. It is on this account that the little cap *c* is employed, having a small hole in the thin plate, which serves as a cover to it; and there are several of these little caps, with holes of smaller and larger sizes, to be changed and applied whenever a flame is required to be more or less strong.

4. Another convenience of these little caps is, that even in case any moisture should escape falling into the hemisphere *bb*, and pass along with the wind through the crooked pipe *Q*, it never can arrive at nor obstruct the little hole of the cap *c*, there being room enough under the hole in the inside, where this moisture must be stopped till it is cleaned and wiped out.

The stream of air that is impelled by the blow-pipe (as seen in fig. 3.) upon the flame, must be constant and even, and must last as long as the experiment continues to require it. This labour will fatigue the lungs, unless an equable and uninterrupted inspiration can at the same time be continued. To succeed in this operation without inconvenience, some labour and practice are necessary, as already explained under the detached article.

Every assay ought always to begin by the exterior flame, which must be first directed upon the mass under examination; and, when its efficacy is well known, then the interior blue flame is to be employed.

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After the ore is roasted, it is to be rounded upon the steel plate by the hammer; the particles being prevented from being dissipated by the ring H (fig. 9. Plate XCIX.), within which the pieces to be broken are to be put.

Among the apparatus, beside the particulars already mentioned, three phials are necessary, containing the required fluxes, viz. the *borax*, the *sal soda*, and *sal fusibile microcosmicum*. Other useful particulars are, A small link of hard steel, to try the hardness or softness of mineral substances, and also to strike fire for lighting the candle when required: A piece of black flint, to serve as a touch-stone; (for being rubbed with any metal, if it be gold the marks will not be corroded by aqua fortis); and also to strike fire, when necessary, with the link of steel: An artificial load-stone, properly armed with iron, for the better preservation of its attractive power; (it serves to discover the ferruginous particles of any ore after it has been roasted and powdered :) A triple magnifier, which, differently combined, produces seven magnifying powers, the better to distinguish the structure and metallic parts of ores, and the minute particles of native gold, whenever they contain that metal: A file, to try the hardness of stones and crystals, &c.: Some pieces of dry agaric or tinder, and small bits or splinters of wood tipped with brimstone, to serve as matches for lighting the candle; and various other little articles of use in these experiments.

II. For performing experiments in the *Humid Way*, the chief additional articles (and which must be kept in a separate case) consist of a collection of phials, containing the principal acids, tests, precipitants, and re-agents, both for examining mineral bodies by the humid way, and for analysing the various kinds of mineral waters. Those with acids and corrosive solutions have not only ground stopples, but also an external cap to each, ground over the stopple, and secured downward by a bit of wax between both, in order to confine the corrosive and volatile fluids within. But those which contain mild fluid liquors have not such external caps; and those with dry inoffensive substances are only stoppered with cork. Besides these phials, there are two smaller cylindrical ones, which serve to exhibit the changes of colour produced by some of the re-agents in those analytical assays. There are also two or three small matrasces, to hold the substances with their solvents over the fire; a small glass funnel for pouring the fluids; a small porcelain mortar, with its pestle; one or two crucibles of the same substance; a small wooden trough to wash the ground ores; some glass sticks to stir up the fluid mixtures; and, finally, pieces of paper tinged red, yellow, and blue, by the tinctures of Fernambuc wood (commonly called Brasil wood), turmeric, and litmus, thickened with a little starch.

The following list contains the names of the various fluid tests and re-agents that are necessary for these assays. But the whole number being too large to be all contained in a portable case, every one may give the preference to those he likes best.

1. Concentrated vitriolic acid, whose specific gravity may be expressed in the outside.
2. Nitrous acid, purified by the nitrous solution of silver.

3. Concentrated marine acid, with its specific gravity.
4. Marine acid dephlogisticated.
5. Aqua regia for gold, viz. 2 nit. and 1 marine.
6. Aqua regia for platina, viz. half marine and half nitrous acid.
7. Nitrous solution of silver.
8. Nitrous solution of mercury, made in the cold.
9. Muriatic solution of barytes.
10. Nitrous solution of lime.
11. Muriatic solution of lime.
12. Mercury in its metallic state.
13. Corrosive sublimate of mercury.
14. White arsenic.
15. Nitrous solution of silver.
16. Nitrous solution of copper.
17. Acid of sugar.
18. Liquor probatorius vini.
19. Hepar sulphuris.
20. Oil of tartar *per deliquium*.
21. Salt of tartar.
22. Caustic vegetable alkali.
23. Pearl-ashes.
24. Soap-makers ley.
25. Common salt.
26. Vitriolated argilla (alum.)
27. Vitriol of iron (copperas.)
28. Nitrous solution of silver.
29. Acetous solution of lead.
30. Acetous solution of barytes.
31. Phlogisticated alkali by the Prussian blue.
32. Lime-water.
33. Lime-water phlogisticated by the Prussian blue.
34. Caustic volatil alkali.
35. Mild volatile alkali (dry.)
36. Rectified spirit (alcohol.)
37. Æther.
38. Spirituous tincture of galls.

The following tests are very fit also for these assays viz. 39. Spirituous solutions of soap; 40. Syrup of violets; 41. Tincture of litmus; 42. Tincture of Brasil wood; 43. Tincture of turmeric; 44. Oil of olives; 45. Oil of linseed; 46. Oil of turpentine; 47. Essential salt of wild-forrel; 48. Hepar sulphuris; 49. Sugar of lead; 50. Solution of alum.

The method of applying the above tests of acids and re-agents may be seen in Bergman's treatises of the Analysis of Waters, and of Assaying by the Humid Way; in Kirwan's Elements of Mineralogy; in the Elements of Chemistry of Dijon; in the Memoirs of the same Academy; in Fourcroy's Lectures of Chemistry, &c.

III. The *Lamp-furnace Laboratory*, for experiments both by the *humid* and the *dry* way, is a very curious and useful, though small apparatus. It is an improvement of that which was contrived by M. de Morveau, in consequence of the information he received from his friend the president de Virly, who saw at Upsal how advantageously the late eminent professor Bergman availed himself of this convenience for many analytical processes in miniature, by the use of very small glass vessels about one inch diameter, and other implements of proportional size, for performing various chemical operations. (See the Dijon Memoirs for 1783, Part 1. p. 171.)

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Apparatus.

There can be no doubt but that whenever these processes are properly conducted, though in miniature, the lamp-furnace will prove amply sufficient to perform in a few minutes, and with very little expence, the various solutions, digestions, and distillations, which otherwise would require large vessels, stills, retorts, reverberatory furnaces, &c. to ascertain the component parts of natural bodies; though it is not always sufficient to ascertain their respective quantities. In this last case, operations must be performed in great laboratories, and on a large scale, at a considerable expence. But the substances are sometimes too valuable; as, for instance, when precious stones are examined; and of course the last way never can be attempted in such cases.

These small processes have likewise another advantage before noticed, which cannot be obtained in works at large. It consists in one's being able to observe the gradual progress of each operation; of easily retarding or urging it, as it may require; and of ascertaining at pleasure each step of every experiment, together with the phenomena attending the same.

Plate
CCCXIII.

The lamp-furnace is mounted in a small parallelogram of mahogany, about six inches long and four wide, marked fig. 5. This is kept steady over the edge of a common table, by means of the metallic clamp *wv*, which is fastened by the screw *x*. The pillar *rs* is screwed in a vertical position on the plate *s*, being about ten inches high; the other is screwed to the opposite corner, marked *pk*, and is only $7\frac{1}{2}$ inches long; both are composed of two halves, that screw at *tt*, to be easily packed up with all the implements in a case covered with black fish-skin, and lined with green velvet, like the other laboratory already described.

The lamp *k*, fig. 3. is supported on the plate *f*, which has a ring *l* that runs in the column *pk*, and may be fixed by its screw *l* at the required height.—This lamp has three small pipes of different sizes, to receive as many wicks of different thickness, and to be filled with spirit of wine. By a similar method, a piece of charcoal is mounted and supported by the pliers or little forceps screwed to the arm *ac*, fig. 1. which has all the motions requisite for being fixed by means of proper screws, at a proper distance from the flame of the wick *b*. The blow-pipe, fig. 4. is, by a similar mechanism, mounted on the smaller column *pg*, at such a distance as to blow the flame *hi* to the piece of ore *m*, which is upon the charcoal *gf*.

Every thing being disposed in this manner, the operator blows through the mouth-piece of the blow-pipe, fig. 4. and remains with his hands free to make the changes and alterations he may think proper.—

[*N. B.* The large round cavity *e* in the middle of the parallelogram, fig. 5. is to receive the lamp *k*, fig. 3. when all the implements are packed up in their case of black fish-skin; and the cover of the lamp is represented by fig. 12.]

But if the operator has the double bellows, fig. 14. and 15. he fixes them, at a due distance, to the same table by the brass clamp *y*. He then unscrews the blow-pipe at *zz*: joins the mouth *m* of the flexible tube to the hemisphere *zz*, passing each orifice, thro' the leather tube fig. 11. and tying both ends with a waxed thin pack-thread. If he works with his foot

on the pedal, the string of which is seen hanging from the end of the bellows, fig. 15. (and is always up, on account of the weight *e*), then the air is absorbed by the bellows fig. 15. from whence it is propelled by the motion of the foot on the pedal to the bellows, fig. 14. whose constant weight *r* drives it out through the flexible pipe, fig. 10. it of course enters the curved part *zzi* of the blow-pipe, and drives the flame on the piece *m* of the ore, that is to be examined upon the charcoal.

[*N. B.* 1. This double bellows is packed up by itself in a mahogany case, about 9 inches long, $6\frac{1}{2}$ wide, and about $3\frac{1}{2}$ deep, outside measure. 2. The last blowing bellows, fig. 14. has an inside valve, which opens when the upper surface of it is at its greatest height; in order to let the superfluous air escape out, as it would otherwise issue with great velocity out of the tube, fig. 11. and spoil the operation.]

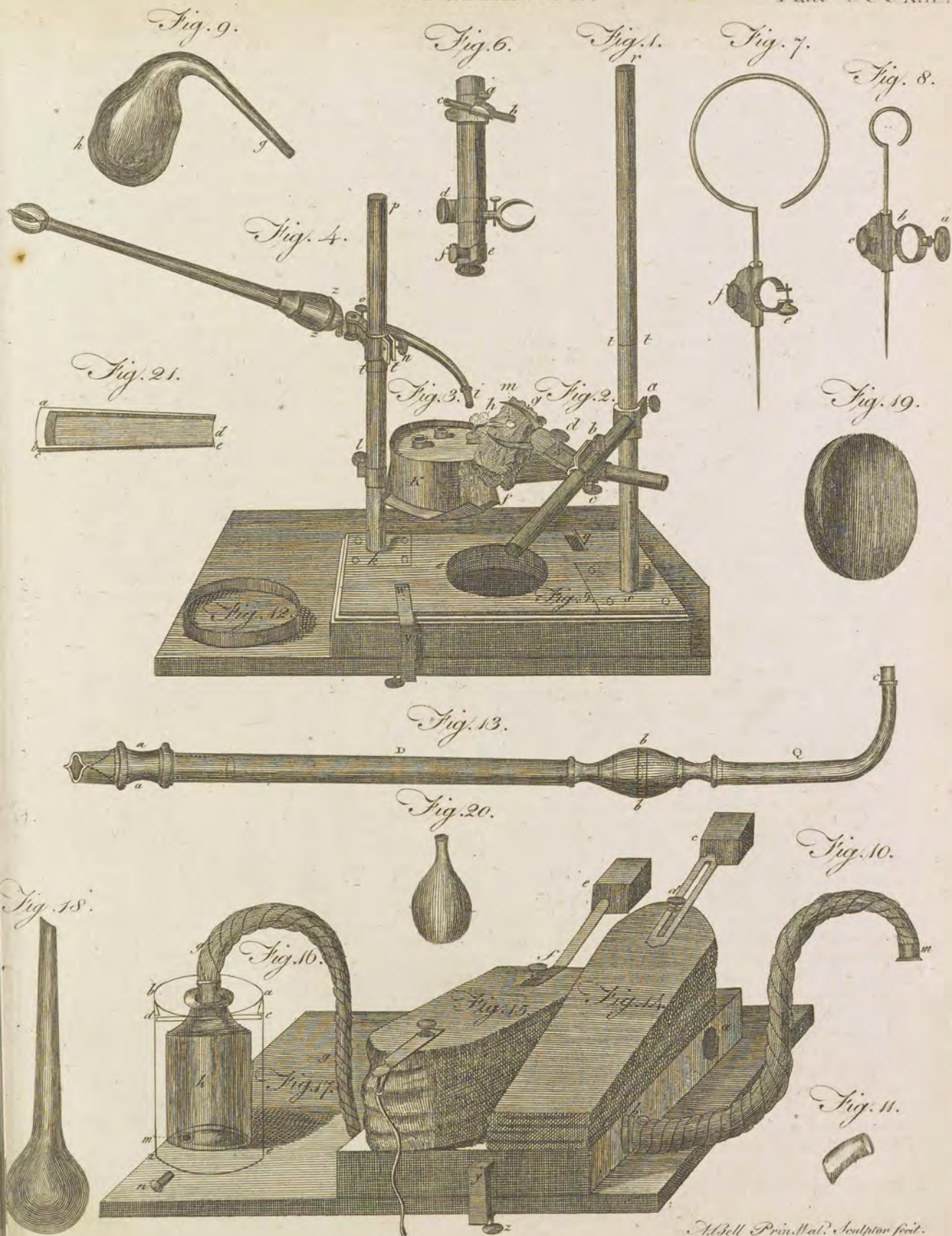
If the operator chooses to apply the vital or dephlogisticated air in his process, let him fill the glass-jar *b*, fig. 17. with this air; and put it within the tub marked by *abze*, filled with water, fastening the neck of the jar within by a cross-board *ed*, which has a hole in it for that purpose; then introducing the two ends of the flexible hollow tube, fig. 16. both to the mouth of the jar and to the hole of the bellows fig. 15. he opens the hole *m* of the jar, that was stopped with the stopple *n*; the column of the water passes in through *m*, and forces up the vital air, which enters the bellows, and of course, by the alternate motion of the pedal, passes through the end of the blow-pipe, to urge the flame upon the piece of ore *m*, fig. 2. on the charcoal *g*. But the dephlogisticated air may be also received at the same time that it is produced, by tying the pipe, fig. 16. to the mouth of an earthen retort, or even of a glass retort well-coated, according to the method of Mr Willis, described in the Transactions of the Society of Arts, Vol. V. p. 96. This last consists in dissolving two ounces of borax in a pint of boiling water, and adding to the solution as much slacked lime as is necessary to form a thin paste. This glass retort is to be covered all over with it, by means of a painter's brush, and then suffered to dry. It must then be covered with a thin paste made of linseed oil and slacked lime, except the neck that enters into the receiver. In two or three days it will dry of itself; and the retort will then bear the greatest fire without cracking. Two ounces of good nitre, being urged in the retort, by a good fire on a chafing-dish, will afford about 700 or 800 ounce-measures of dephlogisticated air.

To make any other kind of chemical assays, the forceps of fig. 2. which supports the charcoal, is taken off, by unscrewing the screw *b*; the blow-pipe is also taken off, by loosening the screw *n*; the hoop fig. 7. is put in its place, where the metallic basin of fig. 19. is put filled with sand: the piece of fig. 8. is set on the other pillar *rs*, fig. 1. to hold the matrafs, fig. 18. upright, or the receiver fig. 20. &c.

In the same manner, the retort, fig. 9. may be put in the sand-bath instead of the matrafs, with its receiver fig. 20. which may be supported on a bit of cork or wood, hollowed to its figure, and held by the pliers, instead of the charcoal fig. 2.

But if the operation is to be made in the naked fire,

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Of
Arrangement.

fire, the neck of the retort, fig. 9. being luted to the receiver, or balloon, fig. 20. may be hanged by a little chain with its ring over the flame, being suspended from the piece of fig. 7. or 8. screwed to either of the pillars as may be most convenient. Otherwise the receiver, fig. 20. may be supported by the round hoop of brass, fig. 8. or 7. screwed at a proper height to the pillar, fig. 1. tying round it some packthread to defend the glass from the contact with the metallic support.

The piece of fig. 6. may be screwed by its collar and screw *ef* to any of the pillars; carrying with it the retort and its receiver, at proper distances, higher or nearer to the lamp according as the flame is more or less violent.

It easily may be conceived, that these implements afford all sorts of conveniences for making any kind of small operations and assays in miniature, provided the operator pays a proper attention to the disposition requisite for each process or operation.

Every glass retort, receiver, matrass, basin, small funnels, &c. are made by the lamp-workers, that blow beads, thermometers, and other small glass instruments.

It is directed that the lamp *k*, fig. 3. be filled with spirit of wine, because it gives no disagreeable smell, and does not produce any fuliginous and disagreeable crust on the vessels as oil does: moreover, the spirit gives a dry flame, without smoke, and stronger than oil; besides the spots and disagreeable consequences this last causes, if split, &c. M. de Morveau adds, that the expence of spirit is quite inconsiderable; and that he performed in eight or ten

minutes, with this apparatus, various dissolutions, evaporations, and other processes, which otherwise would have taken more than three hours, with the expence only of two or three halfpence for the spirit of wine, whilst the fuel of charcoal would have cost near ten or eleven pence.

But a very important circumstance is, as Morveau observes likewise, that many philosophers do not apply themselves to chemical operations, for want of opportunity of having a laboratory to perform them: it requiring a proper room, and suitable expences of many large furnaces, retorts, crucibles, and numerous other implements, &c. whilst these miniature laboratories may in great measure afford the same advantages; at least to that degree of satisfaction sufficient to ascertain the contents and products of any substance that is subjected to trial: for with this simple apparatus a man of some abilities may, without any embarrassment, in a very short time, and with little expence, perform such distillations as require a reverberatory furnace; all sorts of processes, digestions, and evaporations, which require a regular sand heat; he may vary his experiments or trials, and multiply them to a great number of various performances, draw up his conclusions, and reason upon them, without loss of time, without the hinderance of long preparations to work at large. And even when such large works are to be performed, he may observe beforehand various phenomena of some substances, which being known in time, would otherwise impede the processes at large, or make them fail absolutely; and all this without the risk of a considerable loss, and without exposing himself to a great fire, &c.

Of
Arrangement.

PART II. ARRANGEMENT (A) of MINERAL BODIES (B).

THE bodies belonging to the mineral kingdom are divided into four different classes, viz.

1. *Earths* (c), or those substances which are not ductile, are mostly indissoluble in water or oil, and preserve their constitution in a strong heat.
2. *Salts*: these dissolve in water, and give it a taste; and when the quantity of water required to keep them in dissolution is evaporated, they concrete again into solid and angular bodies.
3. *Inflammables*, which can be dissolved in oils, but not in water, and are inflammable.
4. *Metals*, the heaviest of all bodies; some of which are malleable, and some can be decomposed.

Here, however, it must be observed, that these classes are unavoidably blended one with another; and therefore some exceptions must be allowed in every one of them: for instance, in the first class, the calcareous earth is in some measure dissoluble in water, and pipe-clay with some others diminish somewhat in their bulk when kept for a long time in a calcining heat.

In the third class, the calx of arsenic has nearly the same properties as salts; and there is no possible definition of salt that can exclude the arsenic, though at the same time it is impossible to arrange it elsewhere than among the semimetals. In the fourth class it is to be observed, that the metals and semimetals, perfect or imperfect, have not the same qualities common to them all; because some of them may be calcined, or deprived of their phlogiston, in the same degree of fire in which others are not in the least changed, unless particular artifices or processes are made use of: some of them also may be made malleable, while others are by no means to be rendered so. That the convex surface metals take after being melted, is a quality not particularly belonging to them, because every thing that is perfectly fluid in the fire, and has no attraction to the vessel in which it is kept, or to any added matter, takes the same figure; as we find borax, *sal fusibile microcosmicum*, and others do, when melted upon a piece of charcoal: therefore, with regard to all that has

(A) According to the system of Cronstedt †; altered, augmented, and improved from the Observations of other Mineralogists.

(B) Of the different bodies enumerated in the following classification, full explanations are given under their respective names as they occur in the course of this Work. See also METALLURGY, and CHEMISTRY, in 2 vols. by Magellan.

(C) By *earths*, the author (Mr Cronstedt) does not mean (strictly speaking) only earths, but includes under that title all the kinds of stones or fossils not inflammable, saline, or metallic.

† Cronstedt's
Mineralogy,
in 2 vols.
by Magellan.

Earths. has been said, it is hardly worth while to invent such definitions as shall include several species at once; we ought rather to be content with perfectly knowing them separately.

These bodies are here arranged according to their constituent parts, so far as hitherto discovered; and are divided into five orders. See the article EARTH. **Calcareous Earths.**

CLASS I. EARTHS.

EARTHS, are those mineral bodies, not ductile, for the most part not dissoluble in water or oils, and which preserve their constitution in a strong heat.

Order I. CALCAREOUS EARTHS (D).

THE properties of these are as follow:

1. Friability and falling into a fine white powder after calcination.
2. Partial solution in water, with which they contract

(D) Calcareous earth is most commonly found in the form of lime-stone; hard, compact, and of various colours; under which general name may be comprehended all the different kinds of marbles. Near Bath in England is found a kind of grey stone, rather soft than hard. This contains calcareous earth in a mild state, and likewise some in a state of causticity: hence, when newly dug out of the earth, it will dissolve sulphur, or make lime-water without any calcination. By attraction of fixed air from the atmosphere, it soon hardens after it has been dug up.

Mr Williams * divides the lime-stones of Scotland into the following species:

1. Grey, whitish, and pure white; regularly stratified; of a granulated texture; and much used in the Highlands for building bridges. Some of it is composed of fine glittering spangles like the scales of fishes; and some is as pure white as the best refined sugar, which kind he thinks may be called *Parian marble*.

2. Coarse-looking grey mountain limestone, hard and strong, of a granulated texture, difficult to work in some places rough and unequal, in others smooth and even. Sometimes regularly stratified, at other times appearing like one vast irregular bed or rock, of various thicknesses.

3. Ash-coloured mountain-limestones, consisting of small grains of a fine smooth texture; when broken resembling flint. In the Highlands there are hills of this kind of stone, which our author informs us he has seen; some of which have regular strata, while others appear in one vast mass like a rock of granite.

4. Regularly-stratified lime-stone, found in the low countries, exhibiting a vast variety of colours; as black, blue, grey, brown, purple, red, and ash-coloured, with various mixtures, of all degrees of hardness and purity.

5. Limestone accompanying coal, and frequently the immediate roof of the vein. This likewise shows a great variety of colour, texture, and quality; some being so much adulterated with clay and other heterogeneous mixtures as to be good for nothing, while others are very pure and fine. These limestones are always found in regular strata. "They are found (says our author) as regular as the coals they accompany; and the coal-strata are more regular in continuation upon the bearing, as far as the class of strata belonging to the coal reaches, than any other that I have investigated; and I look upon it, that this observation may be of use in practice."

For discovering limestone at some distance, Mr Williams gives the following directions:—"Let them keep the line of stretch, or bearing of the strata; and, in the coal-country, they will be sure to discover it at nearly the same parallel distance from a seam of coal or other given stratum, as the place where it was last seen. But many of the mountain-limestones are not much to be depended on. Though you may have a good and plentiful quarry in one place, yet, perhaps, half a mile, or half a quarter of a mile farther forward, you cannot discover it; it is dwindled away to nothing, and yet will appear again farther forward; which makes the mountain-limestones uncertain to be discovered where you do not see them; as these rocks very frequently grow thicker or thinner, and sometimes squeezes out to nothing; and I comprehend under this denomination all the limestones not accompanying the coals and coal-metals.—The limestones of the coal-fields are often distinguishable by containing a great variety of shells, coral, and other marine bodies, which are found blended in the heart and composition of the stone."

6. The Scotch marbles are of great variety and beauty; and the parts of the kingdom most unfit for cultivation are found to abound most in them. Aflint in Sutherland has a kind of white statuary marble, which Mr Williams says is the purest and best he ever saw. "I am persuaded (says he) there is none better, if any so good, in all Europe, and there is enough of it to serve all Britain; perfectly solid and pure, free of any blemishes, flaws, or stains, and blocks or slabs of any size may be cut out; but there is bad access to it; nor would it be easily quarried, there being a little cover above it, of a soft, loose, whitish limestone. This marble accompanies a prodigious rock of grey limestone, of a granulated texture, appearing in regular strata at Aflint; but it is one of those which varies in thickness as you advance along the bearing of the strata. The good white marble of Aflint is only to be seen in the bed of the river, near a considerable house a mile or two south of the church; but I cannot remember the name of the particular place."

Near Blairgourie in Perthshire, not far from the side of the high road, is an excellent, granulated, broad-bedded limestone, of a sugar-loaf texture, and as white as the finest statuary marble, which Mr Williams supposes to be a good species of the true Parian marble, and that it requires only to be known and brought into use to become of great value. In the duke of Gordon's lands, in the forest of Glenavon, there is also a kind of marble composed of broad glittering grains like spangles, as large as the scales of fishes; but the situation is remote, and difficult of access.

* Nat. Hist.
of the
Mineral
Kingdom,
2 vols.

Calcareous Earths. tract great heat, and by sprinkling with water they fall more readily into powder.

3. Infusibility without addition.

4. They attract the fixed air from the vegetable and mineral alkalies, and thus rendering them much more caustic, becoming at the same time mild themselves.

5. Solubility in all acids except the vitriolic, tartarous, and some anomalous vegetable acids.

6. Fusibility with borax and microcosmic salts.—The fusion is attended with effervescence, and the result is a transparent and colourless glass.

7. With metalline calces they melt into a curdlike slag.

8. They imperfectly reduce the calces of lead and bismuth, and have even some effect upon those of copper and iron.

The calcareous earth is found,

I. Pure.

1. In form of powder. *Agaricus mineralis*, or *lac lunæ*.
a. White, in moors, and at the bottom of lakes.
b. Red.
c. Yellow.

2. Friable and compact. Chalk, *creta*.
a. White, *creta alba*. Chalk is a name applied to other earths; whence we hear of chalks of various colours: but there are none which are known to be of a calcareous nature, except this kind here described, and of which there are no other varieties, otherwise than in regard to the looseness of the texture, or the fineness of the particles.

3. Indurated, or hard; Limestone; *Lapis calcareus*.

A. Solid, or not granulated.

- a. White.
- b. Whitish yellow.
- c. Flesh-coloured, found in loose masses.
- d. Reddish brown.
- e. Grey.
- f. Variegated with many colours, and particularly called *marble*.
- g. Black.

B. Grained or granulated limestone.

1. Coarse-grained, and of a loose texture, called *salt-flag* in Swedish, from its resemblance to lumps of salt.
a. Reddish yellow. b. White.

2. Fine-grained.

a. White. b. Semi-transparent, from Solfatara in Italy, in which native brimstone is found.

3. Very fine grained.

a. White and green. b. White and black.

C. Scaly limestone.

1. With coarse or large scales.

a. White. b. Reddish yellow.

2. With small scales.

a. White.

3. Fine glittering or sparkling.

a. White. b. Of many colours.

D. Lime or calcareous spars.

- (1.) Of a rhomboidal figure.

A. Transparent or diaphanous.

1. Refracting spar; *Spatum islandicum*; Iceland spar, or Iceland crystal.—This represents the objects seen through it double.

2. Common spar, which shows the object single.

a. White, or colourless.

b. Yellowish and phosphorescent.

B. Opaque.

1. White. 2. Black. 3. Brownish yellow.

- (2.) Foliated or plated spar.

a. Opaque white.

E. Crystallized calcareous spars. *Spar. Drusen* (E.)

- (1.) Transparent.

a. Hexagonal truncated.

b. Pyramidal.

1. Dog's teeth; *Pyramidales distinctæ*.

2. Balls of crystallized spar, *Pyramidales concretæ*.

F. Stalactitical spar; *Stalactites calcareus*. Stalactites, Stone-icicle, or Drop-stone.

- (1.) Scaled stalactites of very fine particles.

a. Of a globular form.

1. White, the pea-stone.

2. Grey, *pisolithus*, *oolithus*. Also the hammites, from its resemblance to the roes or spawn of fish. It has been exhibited by authors as petrified roes. The Ketton free-stone, of Rutlandshire, is a remarkable stone of this sort.
b. Hollow, in the form of a cone.

1. White.

c. Of an indeterminate figure.

d. Of coherent hollow cones.

- (2.) Solid stalactites of a sparry texture.

a. Hollow, and in form of a cone.

1. White, and semitransparent.

II. Sa-

In Lochaber, near the farm-houses on the north side of the ferry of Ballachylish, is a limestone or marble rock, of a beautiful ashen-grey colour, and a fine regular uniform grain or texture; capable of being raised in blocks or slabs of any size, and of receiving a fine polish. It is beautifully sprinkled with fine bright grains of mundick or pyrites, and likewise with grains or specks of beautiful lead ore of a fine texture.

About three miles south of Fort-William, in the bed of a river, is a curious kind of marble with a black ground, flowered with white, like fine needle-work, or rather resembling the frost flowering upon glass windows in winter; and this flowering is not only on the outside, but quite through all parts of the body of the stone.

Scotland has also chalk in abundance; some of which is regularly stratified, and much appears in thick irregular masses like sediment.

(E) The translator of Mr Cronstedt's Treatise has adopted this German term *drusen* into the English language, for a cluster of regular figured bodies, as a groupe conveys the idea of a cluster only, whether regular or of indeterminate figures.

Calcareous
Earths.Calcareous
Earths.II. Saturated or combined with the acid of vitriol.
Gypsum, Plaster-stone, or Parquet.

1. Looser and more friable than a pure calcareous earth.
2. Either crude or burnt, it does not excite any effervescence with acids; or, at most, it effervesces but in a very slight degree, and then only in proportion as it wants some of the vitriolic acid to complete the saturation.
3. It readily falls into a powder in the fire.
4. If burnt, without being red-hot, its powder readily concretes with water into a mass, which soon hardens; and then,
5. No heat is perceived in the operation.
6. It is nearly as difficult to be melted by itself as the limestone, and shows mostly the same effects with other bodies as the lime-stone: the acid of vitriol seems, however, to promote its vitrification.
7. When melted in the fire with borax, it puffs and bubbles very much, and for a long while, during the fusion, owing to the nature of both the salts.
8. When a small quantity of any gypsum is melted together with borax, the glass becomes colourless and transparent; but some sorts of alabaster and sparry gypsum, when melted in some quantity with borax, yield a fine transparent yellow coloured glass, resembling that of the best topazes. This phenomenon might probably happen with every one of the gypseous kind. But it is to be observed, that if too much of such gypsum is used in proportion to the borax, the glass becomes opaque, just as it happens with the pure limestone.
9. Burnt with any inflammable matter, it emits a sulphureous smell; and may as well by that means, as by both the alkaline salts, be decomposed; but for this purpose there ought to be five or six times as much weight of salt as of gypsum.
10. Being thus decomposed, the calx or earth which is left shows commonly some marks of iron.

The gypseous earth is found,

- (1.) Loose and friable. Gypseous earth, properly so called; *Gubr.*

A. White.

- (2.) Indurated.

A. Solid, or of no visible particles, Alabaster.

a. White, alabaster.

1. Clear and transparent.

2. Opaque.

b. Yellow.

1. Transparent, from the Eastern countries.

2. Opaque.

B. Gypsum of a scaled or granulated structure. This is the common plaster-stone.

1. With coarse scales. a. White.

2. With small scales. a. Yellowish. b. Greyish.

C. Fibrous gypsum, or plaster-stone, improperly (though commonly) called *English talc* by our druggists.

1. With the fibres coarse. a. White, from Livonia.

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2. With fine fibres. a. White.

D. Spar-like gypsum. Selenites, by some also called *glacies marie*; and confounded with the clear and transparent mica.

1. Pure selenites.

A. Transparent.

a. Colourless. b. Yellowish.

2. Liverstone, so called by the Swedes and Germans.

E. Crystallised gypsum. Gypseous drusen.

(1.) Drusen of crystals of pure sparry gypsum.

A. Wedge-formed, composed of a pure sparry-like gypsum.

a. Clear and colourless. b. Whitish yellow.

B. Capillary.

a. Opaque, whitish yellow. b. Hexagonal, prismatic. c. Globular, consisting of cuneated rays proceeding from the centre.

F. Stalactitical gypsum. *Gypsum finter.*1. Of no visible particles; in French, *grignard*.

A. Of an irregular figure.

a. Yellow. b. White.

2. Of a spar-like texture.

A. In form of a cone.

a. White and yellow.

B. Of an irregular figure.

a. White.

III. Calcareous earth saturated with the acid of common salt. *Sal ammoniacum fixum naturale.*

This is found, 1. In sea-water. 2. In salt-pits.

IV. Calcareous earth combined or saturated with sparry acid, known by the name of *sparry fluor* and *blue john*.These are commonly called *fluxing*, *vitrescent*, or *glass-spars*; because most part of them have a sparry form and appearance: they are, however, often met in an indeterminate figure.

They are only known in an indurated state, and distinguish themselves from the other earths by the following characters.

1. They are scarce harder than common calcareous spars, and consequently do not strike fire with steel.

2. They do not ferment with acids neither before nor after calcination.

3. They do not melt by themselves; but crack and split to pieces when exposed to a strong fire. But,

4. In mixtures with all other earths they are (generally) very fusible, and especially with calcareous earth, with which they melt into a corroding glass that dissolves the strongest crucibles, unless some quartz or apyrous clay be added thereto.

5. When heated slowly, and by degrees, they give a phosphorescent light: but as soon as they are made red-hot, they lose this quality. The coloured ones, especially the green, give the strongest light, but none of them any longer than whilst they are well warm.

6. They melt and dissolve very easily by the addition of borax; and, next to that, by the microcosmic salt, without ebullition.

A. Indurated fluor.

2

(1.)

- (1.) Solid, of an indeterminate figure; of a dull texture, semitransparent, and full of cracks in the rock.
- a. White.
- (2.) Sparry fluor. This has nearly the figure of spar; though on close observation it is found not to be so regular, nothing but the glossy surfaces of this stone giving it the resemblance of spar.
- a. White. b. Blue. c. Violet. d. Deep green. e. Pale green. f. Yellow.
- (3.) Crystallised fluor.
1. Of an irregular figure. a. White. b. Blue. c. Red.
 2. Of a cubical figure. a. Yellow. b. Violet.
 3. Of a polygonal spherical figure. a. White. b. Blue.
 4. Of an octoedral figure. a. Clear, colourless.
- V. Calcareous earth saturated with a particular acid, perhaps of the metallic kind, viz. the tungstenic acid. The *tungstein* of the Swedes.

This resembles the garnet-stone and the tin-grains; is nearly as heavy as pure tin; very refractory in the are, and excessively difficult to reduce to metal. Iron has, however, been melted out of it to more than 30 per cent. It is very difficultly dissolved by borax and alkaline salts, but melts very easily with the microcosmic salt, giving a black slag; and for this reason the last mentioned salt must be employed in the assays of this stone. It is found,

1. Solid and fine-grained. a. Reddish or flesh-coloured. b. Yellow.
2. Spathose, and with an unctuous surface. a. White. b. Pearl-coloured.

VI. Calcareous earth united with the inflammable substance.

These have a very offensive smell, at least when rubbed. They receive their colour from the phlogiston, being dark or black in proportion as it predominates.

- (1.) Calcareous earth mixed with phlogiston alone; *Lapis suillus*, fetid stone and spar, or swine-stone and spar.

A. Solid, or of no visible or distinct particles.

a. Black.

B. Grained.

a. Blackish brown.

C. Scaly, *particulis micaceis*.

1. With coarse scales, a. Black.

2. With fine sparkling scales. a. Brown.

D. Sparry.

a. Black. b. Light brown. c. Whitish yellow.

E. Crystallised.

1. In a globular form.

VII. Calcareous earths blended with an argillaceous earth. Marle, *Marga*.

1. When crude, it makes an effervescence with acids: but,
2. Not after having been burnt; by which operation it is observed to harden, in proportion as the clay exceeds the calcareous substance.
3. It easily melts by itself into a glass, and even when it is mixed with the most refractory clay.
4. It is of great use in promoting the growth of vegetables, since the clay tempers the drying quality of the calcareous earth.

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5. When burnt in a calcining heat, it readily attracts water: and, exposed to the air, in time it falls into a powder.

The varieties of this kind worthy to be taken notice of, depend on the different quantities of each of their component parts, and on the quality of the clay. The following are specified as examples.

A. Loose and compact, *Marga friabilis*.

a. Reddish brown.

b. Pale red. This, when burnt, is of a yellowish colour, and used for making earthen ware in some places.

B. Semi-indurated; which is nearly as hard as stone when first dug up, but moulders in the open air.

a. Grey. b. Red.

C. Indurated or stone marle.

A. in loose pieces, *Marga indurata amorphæ*; by the Germans called *duckstein* or *topfstein*.

a. White. b. Grey, formed from a sediment which the water carries along with it.

b. In continued strata. Hard stony marle.

VIII. Calcareous earth united with a metallic calx.

Here, as well as in the others, such a mixture or combination is to be understood, as cannot be discovered by the eye alone without the help of some other means.

The subjects belonging to this division lose the property of raising an effervescence with acids, when they are rich in metal, or contain any vitriolic acid. However, there have been found some that contained 20 or 30 per cent. of metal, and yet have shown their calcareous nature by the nitrous acid.

There are no more than three metals hitherto known to be united in this manner with the calcareous earth, viz.

- (1.) With iron. White spar like iron ore, *Minera ferri alba*. The *Stahlstein* or *weisses eisenertz* of the Germans.

1. This ore, however, is not always white, but commonly gives a white powder when rubbed.

2. It becomes black in the open air, as likewise in a calcining heat.

3. In this last circumstance it loses 30 or 40 per cent. of its weight, which by distillation has been found owing to the water that evaporates; and it is possible that some small quantity of vitriolic acid may, at the same time, evaporate with the water.

4. It is of all the iron ores the most easy to melt, and is very corrosive when melted.

This kind is found,

A. Loose; the mouldered part of the indurated sort.

a. Black, like foot.

b. Dark brown, somewhat resembling umbre.

B. Indurated.

1. Solid, of no distinct particles.

a. Red. Looks like red ochre, or the red hæmatites, but dissolves in the acid of nitre with a great effervescence.

2. Scaly, *particulis micaceis*.

a. White.

b. Blackish grey.

3. Spar-like.

a. Light brown.

K

4. Drusen.

4. Drusen.
 a. Blackish brown.
 b. White.
 1. Porous. This is often called *eisen-bleute*, or *flos ferri*.
 2. Cellular.
- (2.) With copper.
 A. Loose and friable. Mountain blue; Germanicè, *Bergblau*. This dissolves in aquafortis with effervescence.
 B. Indurated.
 1. Pure calcareous earth mixed with calx of copper. Armenian stone, *lapis Armenus*.
 2. Gypseous earth united with calx of copper. Is of a green colour; and might perhaps be called *turquoise ore*, or *malachites*; though we do not know if all sorts of turquoise ore are of this nature.
 a. Semi-transparent, is found at Ardal in Norway.
- (3.) With the calx of lead.
 This is a lead ochre, or a spar-like lead-ore, which, in its formation, has been mixed with a calcareous earth, and for that reason effervesces with acids.
 A. Loose and friable.
 1. White.
 B. Indurated.
 1. Scaly.
 a. Yellowish.
 Both these varieties contain a considerable quantity of lead, viz. 40 per cent. more or less; and the calcareous earth is as equally and intimately mixed with it, as in the white iron ore.
- IX. The following compounds of calcareous earth with different mineral substances are added from Mr Kirwan's Elements of Mineralogy.
1. A compound of calcareous and barotical earths: of this species are some yellowish stones found in Derbyshire, consisting of lumps of limestone interspersed with nodules of barotelenite. Many more may occur as compounds of gypsum and barotelenite, fluor and barotelenite, &c. &c.
 2. Compounds of calcareous and magnesian earths; such as,
 - a. The white marble, interspersed with spots of steatites or soap-rock, either green or black, called by Cronstedt *kolmord marble*. This marble is of a scaly texture.
 - b. The *pietra talchina* of the Italians, which consists of white spar with veins of talc.
 - c. The *verde antico* of the Italians, which is a light green marble, with deep green, black, white, and purple spots. According to Mr Bayen, it contains 62 parts of mild calcareous earth, 30 of green talc, 1 of magnesia, and 1 of semiphlogisticated iron.
 3. Compounds of calcareous and argillaceous earths; such as,
 - a. The green Campan marble from the Pyrenées. It is slaty and somewhat magnetic. According to Mr Bayen, it contains 65 of mild calcareous earth, 32 of the argillaceous, and 3 of semiphlogisticated iron.
 - b. The red Campan marble: this is not magnetic; it contains 82 parts of mild calcareous earth, 11 of argillaceous schistus, and 7 of dephlogisticated iron.
 - c. Yellow figured marble from Florence: according to Mr Bayen, it contains 75 parts of mild calcareous earth, 13 or 14 of schistus, and 4 or 5 of dephlogisticated iron.
 - d. Griotte marble from Autun of Burgundy in France: it contains 67 parts of mild calcareous earth, 26 of reddish schistus, 2 of iron, and 1 of magnesian earth.
 - e. The Amandola, which is a green marble, honey-comb like, with white spots. It contains 76 parts of mild calcareous earth, 20 of schistus, and 2 of semiphlogisticated iron. The cellular appearance proceeds from the schistus.
 4. Compounds of calcareous earth and mica; such as,
 - a. The cipolin from Autun in France: it is of a green colour, and consists of 83 parts of chalk, 12 of green mica, and 1 of iron.
 - b. The micaceous limestone, is of a glittering appearance, of various degrees of hardness, and effervesces with acids. Such as the macigno of the Italians; their yellow *pietra bigia*; and their blue *pietra columbina* or *turkina*.
 5. Compounds of calcareous and siliceous earths; such as,
 - a. The calcareous quartz and pudding-stone: this consists of lumps of quartz, and sometimes of felt-spar in a calcareous cement.
 - b. The limestone with veins of quartz; such as the *saxum sablbergense*, and several marbles of Sweden and Siberia, which strike fire with steel.
 6. Calcareous volcanic pudding-stone; such as,
 - a. The *cierchina*, which consists of lumps of spar and lava in a calcareous cement, mentioned by Mr Ferber.
 - b. The marble mixed with veins of black or green lava, mentioned by the same author.
 7. Compounds of calcareous earth, mixed with two or more kinds of earth; such as,
 - a. The cipolin from Rome, which is a green marble with white zones: it strikes, though difficultly, fire with steel: it contains 67,8 parts of mild chalk, 25 of quartz, 8 of schistus, and 0,2 of iron, besides the iron contained in the argillaceous schistus.
 - b. The calcareous porphyry, which consists of quartz, felt-spar, and mica in separate grains, united by a calcareous cement.
 - c. The limestone interspersed with shoerl and mica.
 - d. To these compounds belongs the pyritaceous limestone called by the French *Pierre de St Ambroix*. It is of an iron grey colour, interspersed with shining particles. Its texture is compact, and scarcely gives fire with steel. Its specific gravity is 2,7034. It is soluble in acids, and mostly with effervescence; calcines in a strong fire; makes nitre slightly detonate; and if distilled affords a small portion of vitriolic acid, and some sulphur sublimes. Its component

Ponderous Earth.

ponent parts are 75 of mild calcareous earth and 25 of pyrites; in which are contained 14 of argill, 7 of quartz and sulphur, and 4 of iron.

Order II. PONDEROUS EARTH.

PONDEROUS earth, (*Terra Ponderosa*): Chalk, or talk. See EARTH, Art. I. This is a particular kind of earth (like chalk in appearance, but with some very different properties), discovered in Sweden about 1774, which by its results with other bodies has some similarity to the known alkalis. It has not yet been found pure, but mixed with other substances; however, its great specific weight easily distinguishes it from the others, it being the heaviest of all earths.

1. Its specific gravity when considerably purified by art is 3,773.
 2. This earth combines with aerial acid: and in this case effervesces with stronger acids.
 3. With vitriolic acid it forms the ponderous spar, which is insoluble in water.
 4. Its crystallization, after being combined with the nitrous, or with the muriatic acids, is hardly soluble;
 5. But with acetous acid, it becomes deliquescent.
 6. When pure; viz. without any mixture of acid or alkali, it does not vitrify in the fire.
 7. If deprived of the aerial acid (fixed air) by calcination, is then soluble in 900 times its weight of boiling water. This solution exposed to air, forms a cremor, like that of lime-water in the same circumstances, and like it changes also the vegetable colours.
 8. Whilst combined with aerial acid, it is only soluble in about 1550 times its weight of water, chiefly if the water has been impregnated also with the same aerial acid.
 9. It expels the caustic volatile alkali from ammoniacal salt.
 10. Mixed with brimstone it produces a hepar sulphuris, whose solution in water is but incompletely decomposed either by the nitrous or the muriatic acid, on account of the great attraction between this earth and the acid of sulphur, which is so strong that it
 11. Separates this acid (the vitriolic) from the vegetable alkali.
- I. Combined with aerial acid; *Terra ponderosa acrata*. See CHEMISTRY-Index.
- It resembles alum, but is hard and striated, as if composed of radiating fibres coming from a centre. It is found in Alston-moor in England.
- A. Spar-like gypsum.
1. Semitransparent, *spatum Bononiense*. The Bononian stone, or native phosphorus.
 2. Opaque. a. White. b. Reddish.
- B. Ponderous Drusen spar.
1. Jagged, *cristatum*. These resemble cock's combs, and are found in clefts and fissures accreted on the surfaces of balls of the same substance.
 2. White.
 3. Reddish.
- II. United with phlogiston and the vitriolic acid.

Leberstein of the Germans and Swedes. *Lapis hepaticus*.

This stone in some specimens constantly, but in others only when rubbed, smells like the *hepar sulphuris*, or gun-powder.

It is found.

A. Scaly.

1. With coarse scales. a. Whitish yellow.
2. With fine sparkling scales. a. Black.

Order III. MAGNESIAN, MICACEOUS, and ASBESTINE EARTHS.

§ 1. *Magnesian Earths*.

MAGNESIA is a white, loose, and light earth, only known since the beginning of this century. It is generally found combined or mixed with other heterogeneous substances, as other simple earths are.

1. When pure its specific gravity is 2,330, and then
 2. It neither hardens, contracts, nor melts by the application of heat, even by the solar rays.
 3. But it melts easily with borax, or microcosmic salt; though it is scarcely affected by fixed alkalis or calces of lead.
 4. Mixed with other earths, it produces by fire different hard masses.
 5. It gives no causticity except to the volatile alkali: and
 6. Does not effervesce with any acid.
 7. When mixed with water it shows a very small degree of heat, but without any effervescence. And when the water exceeds the weight of magnesia about 7,692 times, it is totally dissolved.
 - 8 and 9. Being put in water and afterwards dried, it contains $\frac{8}{100}$ parts of its weight; though when saturated with aerial acid, it will absorb and retain after being dried $\frac{66}{100}$ parts of water.
 10. This earth combined with aerial acid is more soluble in cold than in hot water.
 11. Combined with vitriolic acid it crystallizes into a bitter salt, known by the name of *Epsom* and *Seydlitz* or *Seydschultz* salt, which is soluble in little more than its own weight of water.
 12. With nitrous acid it forms a deliquescent salt.
 13. With the muriatic or the acetous acids it does not crystallize: and the mass being dried, attracts humidity from the air.
 14. It has a stronger attraction to the fluor acid than to any other (Berg.): and crystallizes with it into hexangular prisms whose ends are formed of two low pyramids, of three rhombs (*Romé de l'Isle*).
 15. It is not precipitated from other acids by the vitriolic, as calcareous earth is.
 16. According to Lavoisier and Macquer, when magnesia is calcined, it becomes phosphorescent.
- I. Magnesia combined with vitriolic and other acids.
- A. When saturated with the vitriolic acid, it forms a bitter salt, called *English* or *Epsom*, *Seydlitz* or *Sedlitz* salt. The salts known under these different

ferent names only differ from one another on account of some heterogeneous substance, which is combined in them, the vitriolated magnesia being the characteristic and principal ingredient in them all.

- B. Magnesia is found not only combined with the vitriolic acid in the waters of Epsom, Sedlitz, &c. but also with the marine acid to a considerable quantity in sea-water and other salt springs.
- C. It is contained frequently in fresh waters, where it is dissolved by means of a quantity of aerial acid.

II. Combined with other earths.

A. Magnesia, when combined with siliceous earth, is commonly unctuous to the touch, and more or less difficult to be cut or turned in proportion to its different degrees of hardness.

It is not diffusible in water: grows hard, and is very refractory in the fire.

When pounded and mixed with water, it will not easily cohere into a paste: however, if it is managed with care, it may be baked in the fire to a mass, which being broken, shows a dull and porous texture.

It takes for the most part, and without much labour, a fine polish. It is found,

- (1.) Compact and soft; *Smedis*, *Briangon* or French chalk.

a. White, from the Lands-End, in Cornwall.

b. Yellow.

c. Red and white, from the Lands-End: the soap-earth, from Switzerland: it looks like Castile-soap.

- (2.) Solid and compact; of impalpable particles: Steatites or soap-rock.

a. White, or light green. b. Deep green —

c. Yellow.

- (3.) Solid, and of visible particles; serpentine stone.

A. Of fibrous and coherent particles.

This is composed, as it were, of fibres, and might therefore be confounded with the asbestos, if its fibres did not cohere so closely with one another, as not to be seen when the stone is cut and polished. The fibres themselves are large, and seem as if they were twisted.

a. Deep green. It is sold for the *lapis nephriticus*, and is dug at some unknown place in Germany. b. Light green, from Skienhyttan, in Westmanland; is used by the plate-smiths instead of French chalk.

- B. Of granulated particles; fine grained serpentine stone, the Zoebnitz serpentine.

a. Black. b. Deep green. c. Light green. d. Red. e. Bluish grey. f. White. These colours are all mixed together in the serpentine stone from Zoebnitz, but the green is the most predominant colour.

- B. Porcelain earth mixed with iron; *terra porcellanea* This is,

a. Diffusible in water.

a. Red, from Montmartre, and China. The water-clinkers which are imported from certain places in Germany seem to be made of this kind.

- B. Indurated.

1. Martial soap earth.

a. Red.

2. Martial soap rock.

a. Black.

b. Red.

- C. The telgsten of the Swedes; *lapis ollaris*.

a. Light grey. b. Whitish yellow. c. Dark grey. d. Dark green.

The serpentine stone has many varieties; being found, (1.) Veined or spotted with green steatites. (2.) Red, with veins of asbestos. (3.) Red, green, yellow, or black with veins or spots of white calcareous spar, is called *potzevera*. The black is called *nero di prato*; the green *verde di Suza*; but these names are not restrained to this species. (4.) Veined or spotted with gypsum. (5.) Veined or spotted with baroselenite. (6.) Veined or spotted with shifus — And, (7.) With veins of quartz, felspar, or shoerl. (*Kirwan's Mineralogy*.)

What is commonly called *serpentine* is a true *lapis ollaris*; but being variegated with green, yellowish, and brown spots, like the skin of some common serpents, it is called by that name. Great quantities of this stone are found in Italy and Switzerland, where it is often worked into the shape of dishes and other vases. (*Fabroni*.) And the *gabro* of the Italians is nothing else but a kind of serpentine, (*Kirwan*.)

§ 2. Micaceous Earths.

These are known by the following characters:

1. Their texture and composition consist of thin flexible particles, divisible into plates or leaves, having a shining surface.

2. These leaves or scales exposed to the fire lose their flexibility and become brittle, and then separate into inner leaves: but in a quick and strong fire, they curl or crumple, which is a step towards fusion; though it is very difficult to reduce them into pure glass by themselves or without addition.

3. They melt pretty easily with borax, the microcosmic salt, and the alkaline salt: and may by means of the blow-pipe be brought to a clear glass with the two former salts. The martial mica is, however, more fusible than the uncoloured ones: its specific gravity is 3,000.

- A. Colourless or pure mica; daze, glimmer, or glift.

1. Of large parallel plates; Muscovy glass. This is transparent as glass; found in Siberia and Eldalen in the province of Wermeland.

2. Of small plates, from Silberberget, at Runneby, in the province of Blekinge.

3. Of fine particles like chaff; chaffy mica.

4. Of twisted plates; crumpled mica.

- B. Coloured and martial glimmer.

1. Brown, semi-transparent.

2. Of fine and minute scales.

a. Brown. b. Deep green. c. Light green.

d. Black.

3. Twisted or crumpled glimmer.

a. Light green.

4. Chaffy glimmer.

a. Black.

5. Crystallized glimmer.

a. Of concentrated and erect scales.

b. Of hexagonal horizontal plates.

The transparent Muscovy glass is used for windows, and upon all occasions where panes of glass are wanted. Perhaps it might also be advantageously employed to cover houses.

The twisted or crumpled mica, which is found at Hardol in Jemtland, is there manufactured into kettles and other vessels, as also for hearths of chimnies: and the powder which falls in the working may be mixed with the common salt for the distillation of the muriatic acid.

§ 3. *Asbestine Earths.*

These are only yet discovered in an indurated state; and their characters are as follows:

1. When pure, they are very refractory in the fire.
2. In large pieces they are flexible.
3. They have dull or uneven surfaces.
4. In the fire they become more brittle.
5. They do not strike fire with the steel.
6. They are not attacked by acids.
7. They are easily brought into fusion by borax or alkali.

In this section are included both those varieties which by fossilogists have been mentioned under the names of *amiantus* and *asbestos*, and have often been confounded together.

I. *Asbestos*, which is compounded of soft and thin membranes; *amiantus Wallerii*.A. Of parallel membranes: *Corium, five caro montana*, Mountain-leather.

1. Pure. a. White.
2. Martial. a. Yellowish brown.

B. Of twisted soft membranes; mountain-cork.

1. Pure. a. White.
2. Martial. a. Yellowish brown.

II. Of fine and flexible fibres; or earth flax: *asbestos Wallerii*.A. With parallel fibres: *Byssus*.

1. Pure and soft. a. Light green. b. White.
2. A little martial, and more brittle.

a. Greenish, from Bastnas Grufva, at Ryddarhyttan in Westmanland. There it forms the greatest part of the vein out of which the copper ore is dug; a great part of it is consequently melted together with the ore, and is then brought to a pure semi-transparent martial slag or glass.

B. Of broken and recombined fibres.

1. Martial. a. Light green.

Order IV. SILICEOUS EARTHS.

SILICEOUS earth is, of all others, the most difficult to describe and to distinguish perfectly; however, it may be known by the following characters, which are common to all bodies belonging to this order.

1. In its indurated state it is hard, if not in regard to the whole, yet at least in regard to each particle of it, in a degree sufficient to strike fire with steel, and to scratch it, when rubbed against it, though the steel be ever so well tempered.
2. When pure, and free from heterogeneous par-

ticles, it does not melt by itself, neither in a reverberatory nor in a blast furnace.

3. After being burnt, it does not fall to a powder, neither in the open air nor in water, as the calcareous earth does, but becomes only a little looser and more cracked by the fire, unless it has been very slowly, and by degrees, heated.
4. It excites no effervescence with acids.
5. In the fire it melts easiest of all to a glass with the fixed alkaline salt; and hence it has got the name of vitrescent, though this name is, properly speaking, less applicable to this order than to a great many other earths.

To the above we may add the following properties, from Bergman.

6. It is not soluble in any of the known acids, the fluor-acid only excepted. But,
7. It may be dissolved by the fixed alkali, both in the dry and wet way.
8. If the fixed alkali is only half the weight of the siliceous earth, it produces a diaphanous and hard glass: but when it is in a double or triple proportion, then the glass deliquesces of itself by attracting the humidity of the atmosphere.
9. It melts easily with borax; but
10. With microscomic salt it is more difficult, and requires a longer time to melt.
11. This earth has a great analogy to acids, as it is perfectly dissolved in that wonderful natural hot-water-spout above ninety feet high at Geyser, in Iceland, where by cooling it forms a siliceous mass.

§ 1. *Gems, or precious stones.*I. Diamond. *Adamas gemma*. See DIAMOND.

1. Of all stones, it is the hardest.
2. Is commonly clear, or transparent; which quality, however, may, perhaps, only belong to its crystals, but not to the rock itself from which they have their origin.
3. Its specific gravity is nearest 3,500. When brought to Europe in its rough state, it is in the form either of round pebbles with shining surfaces, or of crystals of an octoedral form.
- a. Colourless, or diaphanous, or the diamond properly so called.

But it also retains this name when it is tinged somewhat red or yellow. Being rubbed, it discovers some electrical qualities, and attracts the mastic.

- b. Red; Ruby. *Adamas ruber*; *Rubinus*.—Which, by lapidaries and jewellers, is, in regard to the colour, divided into,
 1. The ruby of a deep red colour inclining a little to purple.
 2. Spinell, of a dark colour.
 3. The balas, pale red, inclining to violet. This is supposed to be the mother of the rubies.
 4. The rubicell, reddish yellow.

However, all others do not agree in the characters of these stones.

II. Sapphire. *Sapphyrus gemma*.

It is transparent, of a blue colour; and is said to be in hardness next to the ruby, or diamond.

III. Topaz.

III. Topaz. *Topazius gemma*.

- a. The pale yellow topaz; which is nearly uncoloured.
- b. The yellow topaz.
- c. Deep yellow, or gold coloured topaz, or oriental topaz.
- d. Orange-coloured topaz.
- e. The yellowish green topaz, or *chrysolite*.
- f. The yellowish green, and cloudy topaz, the *chrysoprasi* (A).
- g. Bluish green topaz, or the beryl.

This varies in its colours; and is called, when

1. Of a sea-green colour, the *aqua-marine*.
2. When more green, the *beryl*.

IV. Emerald. *Smaragdus gemma*.

Its chief colour is green and transparent. It is the softest of precious stones, and when heated it is phosphorescent like the fluors.

- V. To the precious stones belong also the jacinths, or hyacinths; which are crystals harder than quartz crystals, transparent, of a fine reddish-yellow colour when in their full lustre, and formed in prisms pointed at both ends: these points are always regular, in regard to the number of the facets, being four on each point; but the fa-

cets seldom tally: the sides also which form the main body, or column, are very uncertain in regard both to their number and shape; for they are found of four, five, six, seven, and sometimes of eight, sides: further, the column or prism is in some also so compressed, as almost to resemble the face of a spherical faceted garnet.

Mr Cronstedt says, he got some jacinths of a quadrangular figure, which did not melt in the fire, but only became colourless.

- VI. The amethyst is a gem of a violet colour, with great brilliancy, and as hard as the best kind of rubies or sapphires, from which it only differs by its colour. This is called the *oriental amethyst*; and is very rare: when it inclines to the purple, or rosy colour, it is more esteemed than when it is nearer to the blue.

These amethysts have the same figure, hardness, specific gravity, and other qualities, as the best sapphires or rubies; and come from the same places, particularly from Persia, Arabia, Armenia, and the West Indies.

The amethysts called *occidental*, are of the same nature as rock crystals, and have the same gradations. viz. of a violet inclining to the purple

(A) In the *Annals of Chemistry*, Vol. I. we have the following account of the method of digging for the chrysoprasus, and of the earths and stones with which it is accompanied.

This precious stone is found in certain mountains in Silesia, which seem to begin those of Tradas, extending to within half a league of Glatz. These mountains appear, in general, to consist of a number of strata, horizontal or inclined, composed chiefly of substances containing magnesia, but likewise mixed with calcareous, argillaceous, and siliceous earths. The greatest part of these consist of serpentine, mixed with asbestos and anianthus, grey argillaceous earths, boles, and red or green ochres, stone marrow, steatites, or soapstone, and talc. In those mountains also we meet with quartz, petrosilex, opal, and chalcedony, in detached fragments, and sometimes in continued veins. We also discover in them veins of sand, of the nature of granite. Sometimes the serpentine is met with at the surface; sometimes at the depth of 20 or 30 feet. The stone marrow seems here to be produced by the decomposition of a very milky species of opal agate named *cacholong*; for at the depth of 50 feet and upwards the veins of this soapy earth assume a degree of solidity, and we find nothing but hard and semitransparent cacholongs.

The above-mentioned strata are crossed by a great number of cracks filled with green-coloured earths and stones; but these frequently do not contain a single true chrysoprasus. They are sometimes found immediately under the vegetable mould, or at the depth of some feet, in shapeless masses, covered with a heavy clay, and sometimes enveloped by an unctuous earth of a beautiful green colour, which it derives from the calx of nickel. In other places, the chrysoprasus has been found in uneven laminæ of several yards in length and breadth, either immediately under the mould, or in the upper strata of serpentine, which have little solidity; and very beautiful ones have been found at the depth of seven or eight fathoms; and some have been met with in grey clay at the depth of four fathoms. In some places also they are met with in a kind of red ochre, which is attracted by the magnet; in others they are found in the clefts of rocks. The beautiful green chrysoprasus is found most plentifully in the mountain of Glashendorf. In another mountain named Kosmutz, where it is also found, the pieces are so porous, and so much spotted with white, &c. that sometimes upwards of 1000 of them have not afforded one large enough for the use of the jewellers. The defects are frequently only discoverable on polishing, as the green opal, while rough, perfectly resembles the chrysoprasus; but, on polishing the stones in which it is contained, it is detected by its want of lustre.

The quantity in which these stones are found is not sufficient to afford the expences of regular mining; the most profitable way, therefore, of obtaining them is by making trenches in the earth from four to six feet deep. Almost all the mountain of Kosmutz, however, has already been examined in this manner; so that they now dig for the chrysoprasus in quarries by uncovering a bank of earth or stone, and descending to other banks by steps in the open air, so as to throw the rubbish back from bank to bank. This method, however, cannot be continued farther than 24 or 30 feet, otherwise the produce would not defray the expence. The only tools employed in digging for the chrysoprasus are a spade and pick-ax; the former to remove the earth, the latter to detach the chrysoprasus itself from the stones which surround it.

Various accounts have been given of the component parts of this precious stone. Lehmann thinks, that the

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purple or rosy colour, or inclining to the blue; very often they are semi-transparent, without any colour in one end, and violet towards the other. The best are found in the Vic mountains of Catalonia in Spain, and at Wiefenthal in Saxony, as well as in Bohemia in Germany, in Italy, and in the province of Auvergne in France.

Crystals within the geodes, or hollow agathe-balls, are very often found of an amethyst colour, and some are very fine.

What we call *amethyst root*, or *mother of amethyst*, is but a sparry fluor, of which we have plenty in Derbyshire: many fine ornamental pieces are made of this substance in different forms and shapes. These spars are found in insulated masses, sometimes pretty large; but never in the form of large rocks.

VII. The garnet, (*Granatus*.) This stone, when transparent and of a fine colour, is reckoned

among the gems: but it varies more than any, both in the form of its crystals and in its colour, some being of a deep and dark red, some yellowish and purplish, and some brown, blackish, and quite opaque. In general, their lustre is less than that of other gems, as well as their hardness, which yields to the file, although they may strike fire with steel. But as to their form, these crystals take almost all sorts of figures, as the rhomboidal, tetradecahedral, &c. and some are of an irregular form.

Their colour proceeds from the iron which enters into their composition; and, according to M. de Saussure, even the finest oriental garnets attract the magnetic needle at a small distance.

The Syrian garnet is the finest and best esteemed. It is of a fine red, inclining to the purple colour, very diaphanous, but less brilliant than the oriental amethyst. It seems to be the *amethystizans* of Pliny: the Italians call it *rubino di rocca*,

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the colour of it is owing to some ferruginous particles modified in a particular manner: but the experiments he adduces for this opinion are not satisfactory. Mr Sage attributes the colour to cobalt from the blue colour it imparts to glass. Mr Achard thinks the stone contains calx of copper as well as calx of iron; because a part of the metal separable from it may be dissolved in volatile alkali. The following are the experiments of M. Klaproth upon the subject.

1. On heating several pieces of very pure chrysolite red hot, and quenching them in water, the colour was changed from green to bluish grey; and, on repeating the operation, it became a white grey. They were found to have lost in weight one and an half per cent. and were easily pulverable in a glass mortar.

2. Three hundred grains of chrysolite were mixed with double its weight of mild mineral alkali, and the mixture heated for some hours red hot, in a porcelain crucible. The mass was then powdered, and digested in distilled water. By filtration, a yellowish grey residuum was obtained, weighing 44 grains; the filtered liquor was limpid and colourless, a copious precipitate being formed with muriatic acid, which being washed and dried was found to be siliceous earth.

3. The 44 grains of yellowish grey residuum were digested in a retort, with 352 grains of aqua regia; a great part of which was evaporated. The acid which came over was returned into the retort, and filtered after a second digestion. The residuum was a very fine white siliceous earth, which, after being washed, dried, and heated red hot, weighed 20 grains.

4. The filtrated solution was of a pale green, but on supersaturation with volatile alkali immediately turned of a bluish colour, precipitating a small quantity of brownish gelatinous matter; which, when collected, twice distilled with nitrous acid, and afterwards strongly heated, yielded a brown calx of iron, weighing no more than a quarter of a grain: whence our author concludes, that iron does not contribute to the colour of the chrysolite, as we know many colourless stones which contain as great a quantity of that metal. This small quantity of calx was left after digesting the gelatinous residuum. On precipitating the soluble parts, they appeared to consist of aluminous earth, in an excessively divided state; which being washed and dried, weighed half a grain.

5. To find whether the solution contained calcareous earth or not, he mixed with that, supersaturated with volatile alkali, a saturated solution of mild mineral alkali, which precipitated four grains and an half of white and very pure calcareous earth.

6. Nothing more was precipitated from the solution, either by acids or alkalies, after the separation of the calcareous earth, though it still retained a bluish colour. It was poured into a retort, and evaporated to dryness; the residuum was of a yellowish colour, which became green on being dissolved in distilled water. Mild mineral alkali threw down only a little earth of a greenish white colour; which being re-dissolved in dephlogisticated nitrous acid, and precipitated with Prussian alkali, the liquor yielded 17 grains of a sea-green powder. This precipitate, in our author's opinion, is the colouring principle of the chrysolite; and this principle he afterwards found to be calx of nickel.

7. Our author likewise attempted to analyse the chrysolite in the moist way by concentrated vitriolic acid; in which process his chief view was to discover whether or not the stone contained any volatile particles or not. On an ounce of crude chrysolite, therefore, when put into a retort, he poured an equal quantity of rectified vitriolic acid, and two parts of distilled water. After the latter had passed over into the receiver, the fire was increased to force over the superabundant acid; a part arose in white vapours, and some fell into the receiver with an hissing noise. Boiling water, which had been distilled, was then poured upon the residuum, and the solution filtered. The powdered chrysolite left on the filter had not been perfectly dissolved, and,

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rozea, and is found in Syria, Calcutta, Cananor, Camboya, and Ethiopia.

The fine garnet of a red inclining to a yellow colour, is the *foranus* of the ancients, the *vermeille* of the French, and the *giacinto guarnacino* of the Italians. Its name is taken from *Sorian*, or *Surian*, a capital town of Pegu, from whence these gems are brought: when they have a brownish taint, they are then called *hyacinths*.

The occidental garnet is of a deep and dark red, and its hardness is lesser. However, some very fine hard garnets are found in Bohemia.—Garnets are also found in Hungary, at Pyna in Silesia, at S. Sapho in the canton of Berne, in Spain, and in Norway.

The garnet melts in the focus of a good burning glass into a brown mass, which is attracted by the loadstone; and this shows that iron enters considerably into its composition.

Some garnets are found, which contain a little gold. Those called *zingraupen* by the Germans contain tin.

VIII. Tourmalin; *Lapis electricus*.

This is a kind of hard stone, lately brought
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into notice by its electrical properties. See Siliceous
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1. Its form is a prism of nine sides of different breadths, mostly truncated, and seldom terminating in a pyramid at each end, which is either composed of three pentagons, or of nine triangles.
2. When heated in the fire, it gives signs of contrary electricity on the two opposite ends of their prismatic form. But many of these stones are not in the least electric. However, on being rubbed, they become electric in their sides, like other diaphanous gems.
3. It is as hard almost as the topaz, and strikes fire with steel.
4. It melts by itself in a strong fire, though with difficulty.
5. With the microcosmic salt it melts perfectly; but only in part with borax.
6. With mineral alkali it is divided into a kind of powder.
7. The three mineral acids dissolve it when first reduced to a powder.
8. It bears a greater similarity to schoerl than to any other stone: but its component parts show

in general, had undergone but little alteration, so that he could not by this method determine the component parts. M. Achard, however, was more successful, and by a similar method determined the component parts of this gem to be five grains of an earth, which, distilled with vitriolic acid, became volatile; eight grains of calcareous earth, six grains of magnesia, two grains of calx of iron, three grains of calx of copper, and 456 of siliceous earth.

M. Klaproth never met with any volatile earth or magnesia in his experiments on this gem; and therefore concludes, that the chrysoptasus used by him had been essentially different from that made use of by M. Achard; and he seems not to give credit to the account of any copper being found in it.

8. One part of crude chrysoptasus, well powdered and washed with two parts of mild vegetable alkali, yielded a violet-coloured glass, which in the atmosphere ran into a brownish-coloured liquor.

9. Five parts of the gem, with four of mild alkali, gave a beautiful violet-coloured glass after being two hours in fusion.

10. Equal parts of crude chrysoptasus and mild mineral alkali, yielded a transparent glass in thin laminae, of a brown colour, resembling that of the tourmalin, the surface being marked with fine reticulated veins; which veins arose from small grains of very fine reduced nickel placed in lines against one another.

11. Equal parts of crude chrysoptasus and calcined borax, gave a clear, transparent, and brown glass, resembling the smoky topaz.

12. Equal parts of chrysoptasus, extracted by vitriolic acid and calcined borax, yielded a similar glass of a clear brown colour; "which proves (says our author), that the vitriolic acid was incapable of perfectly analysing the chrysoptasus, though I had used a double portion of the earth."

13. Eighty grains of prepared siliceous earth, sixty grains of mild fixed alkali, with three grains of calx of nickel procured from the chrysoptasus, yielded a beautiful, clear, and violet-coloured glass.

14. On substituting three grains of calx produced from an ore of nickel, a glass was produced exactly like the former.

15. Sixty grains of prepared siliceous earth and calcined borax, with three grains of calx of nickel from the chrysoptasus, yielded a transparent glass of a clear brown colour.

16. Sixty grains of prepared siliceous earth and vitrified phosphoric acid, with three grains of calx of nickel from the chrysoptasus, gave a glass of the colour of honey.

17. Thus the attempts of M. Klaproth to recompose the chrysoptasus proved abortive. From his experiments, however, he deduces the following conclusions: 1. The blue colour observable in the glass produced by fusing the chrysoptasus with vegetable alkali, arises entirely from the nickel contained in the gem; and the experiment shows that the calx of nickel, when purified as much as possible, has the surprising property of tinging glass frits prepared with vegetable alkali of a blue colour. "But (says he) why was not this colour also obtained with soda? and what is the cause of a difference so little to be expected?" 2. By these experiments the supposition of M. Sage is refuted, that the metallic matter which colours the chrysoptasus is cobalt: "many metallic substances besides cobalt, it is well known, give by certain processes a blue glass; thus cobalt,

show that it may be ranged with propriety in this place, along with other precious stones: as the argillaceous earth is also the most prevalent in its composition.

a. The oriental tourmalines are found in the island of Ceylon. They are transparent, of a dark brown yellow; and their specific gravity is from 3062 to 3295.

b. From Brasil. Transparent. These are green for the most part; but there are also some red, blue, and yellow; their specific gravity is from 3075 to 3180.

c. From Tyrol. Of so dark a green as to appear opaque. Their specific gravity is about 3050. These are found in beds of steatites and lapis-ollaris, among the micaceous veins, talcs, and hornblende of Schneeberg, Jurzagl, and Zillerthal, in the mountains of Tyrol.

d. From the mountains of Old Castile in Spain. These are transparent, and have the same properties as the preceding ones.

IX. The opal, *Opalus*; the *girafale* of the Italians.—This is the most beautiful of all the flint kind, owing to the changeable appearance of its colours by reflection and refraction, and must therefore be described under both these circumstances.

1. The opal of Nonnius, the *Sangenon* of the Indians. This appears olive-coloured by reflection, and seems then to be opaque; but when held against the light, is found transparent and of a fine ruby red colour.

There is, however, another of the same kind in Sweden, which by reflection appears rather brown; but by refraction it is red, with violet veins.

2. The white opal. Its ground is white, of a glass-like complexion, from whence are thrown out green, yellow, purple, and bluish rays; but it is of a reddish or rather flame-colour when held against the light.

a. Of many colours; the oriental opal.

b. Of a milky colour.

c. Bluish, and semi-transparent. This is not

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so much valued as those which are more opaque, because it is easier to be imitated by art.

§ 2. Of Quartz.

This stone is very common in Europe, and easier to be known than described. It is distinguished from the other kinds of the siliceous order by the following qualities.

1. That it is most generally cracked throughout, even in the rock itself; whereby,
2. As well as by its nature, it breaks irregularly, and into sharp fragments.
3. That it cannot easily be made red-hot without cracking still more.
4. It never decays in the air.
5. Melted with pot-ashes, it gives a more solid and fixed glass than any other of the siliceous order.
6. When there has been no interruption in its natural accretion, its substance always crystallises into hexagonal prisms pointed at one or both ends.
7. It occurs in clefts, fissures, and small veins in rocks. It very seldom forms large veins, and still seldomer whole mountains, without being mixed with heterogeneous substances.

According to Mr Kirwan, quartz neither loses its hardness nor its weight by calcination. Its texture is lamellar. These stones are in general the purest of the siliceous kind, though most contain a slight mixture of other earths; the most obvious distinction among them arises from their transparency or opacity.

Quartz is found,

(1.) Pure.

A. Solid, of no visible particles, with a glossy surface. Fat quartz.

a. Uncoloured and clear. This has no crystallised form, but is nevertheless as clear as quartz crystals of the best water.

b. White, the common fat quartz.

L

c. Blue

cobalt gives a blue colour to combinations of the mineral alkali with phosphoric acid, to mineral alkali itself, to potash, and to borax. The acid of tungsten (falsely so called) also gives a blue colour to frits made with phosphoric salts, but not to those made with borax; the calx of nickel gives a blue colour only to frits made with potash, brown to those with mineral alkali and borax, and yellow, like honey, to combinations of phosphoric acid with mineral alkali." 3. As the chrysoprasus gives a brown colour with borax, and the solution of this stone in muriatic acid gives no signs of cobalt dissolved in the same acid; this shows that there is no cobalt in the stone. Mr Sage, indeed, pretends, that he has obtained a blue glass from the chrysoprasus and borax; but this is contradicted by experience. 4. The mineralogical character of the chrysoprasus, therefore, is a quartz coloured green by nickel. Three hundred grains of it contain $288\frac{1}{2}$ of siliceous earth calcined to redness, one quarter of a grain of pure aluminous earth, two grains and an half of calcareous earth calcined to redness, three grains of calx of nickel, and one quarter of a grain of calx of iron. All these were extracted in the experiments; and there were besides five grains and an half of waste.

Our author mentions, that in the collections of chrysoprasus which have been brought to him, he has constantly observed green opal, in bits of vein from half an inch to an inch, and fixed in its borders: the reddish, yellow, and white opals, on the contrary, are generally met with on a green or brownish petrosilex. But the white opal, which, as well as the green, is found in pieces of the nature of matrix, differs from the true opal, approaching the chalcedony and the opaque milky quartzes. This kind of transparent opal, radiated with a whitish blue, contains the following ingredients in its composition: Siliceous earth, 237 grains; aluminous earth, a quarter of a grain; calx of iron, a quarter of a grain—in all, $277\frac{1}{4}$ grains. In 240 grains were two and an half of waste. The colour of this stone, as well as the chrysoprasus, in our author's opinion, is derived from nickel.

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- c. Blue.
d. Violet.
B. Grained.
a. White. b. Pale green.
C. Sparry quartz.

This is the scarcest; and ought not to be confounded with the white felt-spat, being of a smoother appearance, and breaking into larger and more irregular planes.

- a. Whitish yellow. b. White.
D. Crystallised quartz. Rock crystal. Quartz crystal.
1. Opaque, or semi-transparent.
a. White, or of a milk colour.
b. Red, or of a carnelian colour.
c. Black.
2. Clear.
a. Blackish brown, smoky topaz, or *rauch topaz* of the Germans.
b. Yellow; found in Bohemia, and sold instead of topazes.
c. Violet; the amethyst from Saxony, Bohemia, and Dammore in Upland (B.)
d. Uncoloured; rock crystal, properly so called. When these coloured crystals are not clear, they are called *flufs*; for instance, *topaz-flufs*, *amethyst-flufs*, &c. (C.)
(2.) Impure quartz.
A. Mixed with iron, in form of a black calx.— This is of a glossy texture, and contains a great quantity of iron.
B. Mixed with copper in form of a red calx.
a. Red.

§ 3. Of Flints.

THE flint (*Silex pyromachus*, *Lapis corneus*, or the

hornstein of the Germans) forms a kind of intermediate substance between quartz and jasper; both which, however, it so nearly resembles, that it is not easy to point out such characters as shall readily distinguish it from them. We can only, therefore, speak of its properties comparatively.

1. It is more uniformly solid, and not so much cracked in the mass as the quartz; and,
2. It is more pellucid than the jasper.
3. It bears being exposed to the air without decaying better than the jasper, but not so well as the quartz.
4. It is better for making of glass than the jasper, but is not quite so good as quartz for that purpose.
5. Whenever there has been an opportunity in this matter of its shooting into crystals, quartz crystals are always found in it; just as if the quartz made one of its constituent parts, and had in certain circumstances been squeezed out of it: this is to be seen in every hollow flint, and its clefts, which are always filled up with quartz.
6. It often shows most evident marks of having been originally in a soft and slimy tough state like glue or jelly.

The several varieties of this species have obtained more distinct names with respect to their colours than from any real difference in their substance; but these are still necessary to be retained, as the only names used by jewellers and others, who know how to value them accordingly.

I. Jade. *Lapis nephriticus*. *Jaspachates*.

The true lapis nephriticus seems to belong to this siliceous order, as it gives fire with steel, and is semi-pellucid like flint; it does not harden

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(B) The most transparent are called *false diamonds*, *Bristol*, *Kerry stones*, and *Alençon diamonds*, &c. The coloured transparent crystals derive their tinge generally from metallic calces, though in exceeding small portions: they all lose their colours when strongly heated. These are what we call false gems, viz.

The red, from Oran in Barbary, *false rubies*.

The yellow, from Saxony, *false topazes*.

The green, from Dauphiny, (very rare) *false emeralds*, or *prases*.

The violet, from Vil in Catalonia, *false amethysts*.

The blue, from Puy in Valay, France, *false sapphires*.

There are also *opal*, or *rainbow crystals*, some of which make a very fine appearance; the various colours of which are thrown out in zones across the surface, though they never shine like the oriental opal.

(c) M. Fourcroy makes a remarkable difference between the crystals and the quartz, by affirming that the former are unalterable in the fire, in which they neither lose their hardness, transparency, nor colour; whilst the quartz loses the same qualities, and is reduced by it to a white and opaque earth. He classes the rock crystals,

1st, According to their form, viz. 1. Insulated-hexagonal-crystals, ending in two pyramids of six faces, which have a double refraction, or show two images of the same object when looked through. 2. Hexagonal crystals united, having one or two points. 3. Tetradral, dodecadral, slated crystals; and which, though hexagonal, have nevertheless their planes irregular. 4. Crystals in large masses, from the island of Madagascar, which have a simple refraction.

2dly, As to the colour, they are either diaphanous, reddish, smokey, or blackish.

3dly, As to accidental changes, some are *hollow*: some contain *water* within one or more cavities: some are cased, viz. one within the other: some are of a round form, as the pebbles of the Rhine: some have a crust of metallic calces, or of a pyrites: some are of a geodical form, viz. crystallised in the inside of a cavity: some seem to contain amianthe, or asbestus, and others contain shirls.

The same author reckons among crystals, the oriental topaz, the hyacinth, the oriental sapphire, and the amethyst. Mr Daubenton has always looked on this last as a quartzous crystal.

den in fire, but melts by the solar heat in the focus of a burning lens into a transparent green glass with some bubbles. That called by the name of *circumcision stone*, which comes from the Amazon river, melts easier, in the same solar fire, into a brown opaque glass, which is far less hard than the stone itself. (*Macquer.*)

This stone is superior in hardness to quartz, though from its unctuousity to the touch, one would suspect it to contain a large portion of argillaceous earth, or rather of magnesian earth, as Mr Kirwan seems to suspect.

Its specific gravity is from 2,970 to 3,389.— It is of a granular texture, of a greasy look, and exceedingly hard: is scarcely soluble in acids, at least without particular management, and is infusible in the fire. M. Saussure seems to have extracted iron from it.

a. It is sometimes of a whitish milky colour, from China; but mostly

b. Of a greenish, or

c. Deep-green colour, from America.

d. Grey, yellowish, and olive colour: these are the vulgar *lapis nephriticus*, they being supposed to cure the nephritic pains by their external application to the loins.

The semi-pellucidity, hardness, and specific gravity, are the characters by which the lapis nephriticus may be distinguished from other stones.

II. Cat's eye; *Pseudopalus*. The sun-stone of the Turks, called *guncehe*.

This stone is opaque, and reflects green and yellowish rays from its surface: it is found in Siberia. It is very hard and semi-transparent, and has different points, from which light is reflected with a kind of yellow-brown radiation, somewhat similar to the eyes of cats, from whence it had its name. Jewellers do not fail to cut them round to the greatest advantage. The best of these stones are very scarce. One of these of one inch diameter was in the cabinet of the grand duke of Tuscany.

III. *Hydrophanes*, or *Oculus Mundi*; also called *Lapis mutabilis*.

The principal property which distinguishes this from all other stones, is that it becomes transparent by mere infusion in any aqueous fluid; but it gradually resumes its opacity when dry.

IV. The onyx. *Onyx camebaja*. Memphites. It is found of two sorts.

a. Nail-coloured onyx, having pale flesh-coloured and white lines.

b. With black and white lines. The oriental onyx.

V. The chalcedony, or white agate, is a flint of a white colour, like milk diluted with water, more or less

opaque: it has veins, circles, and round spots. It is said to be softer than the onyx, but much harder than those agates which are sometimes found of the same colour.

a. The white opaque chalcedony, or *cabolong*, from the Buckharish Calmucks. This was first made known by one Renez, a Swedish officer, who for several years had been in that country. The inhabitants find this flint on the banks of their rivers, and work idols and domestic vessels out of it.

b. Of white and semi-transparent strata; from Ceylon.

c. Bluish grey; from Ceylon and Siberia.

VI. The carnelian. *Carniolus*.

Is of a brownish red colour, and often entirely brown. Its name is originally derived from its resemblance to flesh, or to water mixed with blood.

a. Red.

b. Yellowish brown, looks like yellow amber. It is said not to be so hard as the chalcedony.

VII. The sardonyx.

This is a mixture of the chalcedony and carnelian, sometimes stratumwise, and sometimes confusedly blended and mixed together.

a. Striped with white and red strata: this serves as well cut in cameo as the onyx.

b. White, with red dendritical figures. This very much resembles that agate which is called the *mocha stone*; but with this difference, that the figures are of a red colour in this, instead of black, as in that agate.

Between the onyx, carnelian, chalcedony, sardonyx, and agate, there seems to be no real difference, except some inexplicable degrees of hardness.

VIII. The agate; *Achates*.

This name is given to flints that are variegated with different colours, promiscuously blended together; and they are esteemed in proportion to their mixture of colours, their beauty, and elegance. Hence also they have obtained variety of names, mostly Greek, as if the business of the lapidary in cutting of them, and admiring their several beauties and figures, had been derived from that nation alone (D).

a. Brown opaque agate, with black veins, and dendritical figures; the Egyptian pebble.

b. Of a chalcedony colour; *achates chalcedonifans*.

c. Semi-transparent, with lines of a blackish brown colour, and dendritical figures; the *mocha stone*.

d. Semi-transparent, with red dots; *Gemma divi Stephani*. When the points are very minute, so as to give the stone a red appearance, it is by some called *Sardea*.

L 2

e. Semi-

(D) On the side of a hill near the church of Rothés in Moray, is a quantity of fine agate of elegant red and white colours. It is very hard, heavy, of a smooth uniform texture, and of a considerable brightness; in which the red are remarkably clear, and finely mixed and shaded through the stone. Mr Williams says that this is the largest and most beautiful agate rock he ever saw; and so fine and hard as to be capable of the highest lustre in polishing.

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- e. Semi-transparent, with clouds of an orange colour.
- f. Deep red or violet, and semi-transparent.
- g. Of many colours, or variegated.
- h. Black.

IX. Common Flint; *Pyromachus*.

This, in reality, is of the same substance as the agate; but as the colours are not so striking or agreeable, it is commonly considered as a different substance.

- a. Blackish grey, from the province of Skone.
- b. Yellow semi-transparent, from France.
- c. Whitish grey.
- d. Yellowish brown.

When the flints are small, they are in England called *pebbles*; and the Swedish sailors, who take them as ballast, call them *singel*.

X. Chert; *Petrofalex*, *Lapis Corneus*. The *hornstein* of the Germans.

This is of a coarser texture than the preceding, and also less hard, which makes it consequently not so capable of a polish. It is semi-transparent at the edges, or when it is broke into very thin pieces.

- a. Chert of a flesh colour, from Carl-Schakt, at the silver-mine of Salberg, in the province of Westmanland.
- b. Whitish yellow, from Salberg.
- c. White, from Krittersberg, at Nya Kopparberget in Westmanland.
- d. Greenish, from Prestgrufvan, at Hellefors in Westmanland.

Chert runs in veins through rocks, from whence its name is derived. Its specific gravity is from 2590 to 2700. In the fire, it whitens and decrepitates like flint, but is generally so fusible as to melt *per se*. It is not totally dissolved in the dry way by the mineral alkali; but borax and microcosmic salt dissolve it without effervescence. Its appearance is duller and less transparent than common flint. The reddish *Petro-falex* used in the Count de Lauragar's porcelain manufacture, and called there *felt spat*, contained 72 *per cent.* of flint, 22 of argill, and 6 of calcareous earth.

There are not yet any certain characters known by which the cherts and jaspers may be distinguished from each other: by sight, however, they can easily be discerned, viz. the former (the cherts) appearing transparent, and of a fine sparkling texture, on being broken; whereas the jasper is grained, dull, and opaque, having the appearance of a dry clay. The chert is also found forming larger or smaller veins, or in nodules like kernels in the rocks; whereas the jasper, on the contrary, sometimes constitutes the chief substance of the highest and most extended chain of mountains. The chert is likewise found plentifully in the neighbourhood of scaly limestone, as flints in the strata of chalk. What connection there may be between these bodies, perhaps time will discover.

But flints and agates being generally found in

loose and single irregular nodules, and hardly in rocks, as the chert, it is a circumstance very insufficient to establish a difference between them; for there is the agate-stone, near Constantinople, running vein-like across the rock with its country of the same hardness, and as fine and transparent as those other agates which are found in round nodules at Deux-ponts. We must, therefore, content ourselves with this remark concerning flints, viz. That they seem to be the only kind of stone hitherto known, of which a very large quantity has been formed in the shape of loose or separate nodules, each surrounded with its proper crust; and that the matter which constitutes this crust has been separated from the rest of the substance, in like manner as sandiver or glass-gall separates from, and swims upon, glass, during its vitrification; though sometimes the formation of this crust may be prevented by the too sudden hardening of the matter itself.

Other species of stones, which are found in loose pieces or nodules, except ores and some sorts of stalactites, show evidently by their cracks, angles, and irregular figures, that they have been torn from rocks, rolled about, and rubbed against one another in torrents, or by some other violent motions of water.

That flints had originally been in a soft state, M. Cronstedt observes, is easy to be seen in the Egyptian pebbles, which have impressions of small stones, sand, and sometimes, perhaps, grass; which, however, have not had any ingress into the very flint, but seem only to have forced the above agate-gall or crust out of the way.

§ 4. Of Jaspers.

JASPER, *jaspis*, (the *diapros* of the Italians), is a name given to all the opaque flints whose texture resembles dry clay, and which have no other known quality whereby they may be distinguished from other flints, except that they may be more easily melted in the fire; and this quality perhaps may proceed from the heterogeneous mixture, probably of iron.

1. Pure jasper; which by no means yet known can be decomposed.

- a. Green with red specks or dots; the *heliotrope*, or blood-stone. b. Green. c. Red.
- d. Yellow. e. Red with yellow spots and veins. f. Black.

II. Jasper containing iron; *Jaspis martialis Sinople*.

A. Coarse-grained.

- a. Red and reddish brown; *sinople*.

B. Steel-grained, or fine grained.

- a. Reddish brown: looks like the red ochre or chalk used for drawing; and has partition veins, which are unctuous to the touch, like a fine clay, and other like kinds.

C. Of a solid and shining texture, like a slag.

- a. Liver-coloured; and, b. Deep red. c. Yellow. This last mentioned, when calcined, is attracted by the loadstone; and being assayed, yields from 12 to 15 *per cent.* of iron. (E.)

§ 5.

(E) Near Portfooy in Banff-shire is an extensive rock of jasper; some parts of which contain a beautiful mixture of green and red, which appear finely shaded and clouded through the body of the stone when polished. Mr Williams is of opinion that it would be a very valuable quarry if worked.

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§ 5. *Felt-spars.*1. Rhombic quartz; *Spatum scintillans.*

This has its name from its figure, but seems to be of the same substance as the jasper. We have not, however, ranked them together, for want of true marks to distinguish the different sorts of the flinty tribe from one another.

This kind is found,

1. Sparry.

a. White. b. Reddish brown. c. Pale yellow. d. Greenish.

2. Crystallised.

a. In separate or distinct rhomboidal crystals.

II. Labradore stone; *Spatum rutilum versicolor.*

Its colour is commonly of a light or of a deep grey, and mostly of a blackish grey: but when held in certain positions to the light, discovers different varieties of beautiful shining colours, as lazuly-blue, grass-green, apple green, pea-green; and seldom a citron-yellow; some have an intermediate colour betwixt red-copper and tombac-grey; besides other colours between grey and violet. These colours are seen for most part in spots; but sometimes in stripes, on the same piece.

III. White feltspar; *Terra Silicea Magnesia & ferro intimè mixta.*

This stone has been described by Mr Bayen: and is found at St Marie aux mines in Lorrain. —It is of a white opaque colour, spotted with ochre on the outside.

§ 6. *Of the Garnet Kinds.*

THE substances of this genus (which is considered by Cronstedt as an order) are analogous to gems; since all these are composed of the siliceous, calcareous, and argillaceous earths, with a greater or less proportion of iron. The opaque and black garnets contain about 20 hundredths of iron: but the diaphanous ones only two hundredths of their weight, according to Bergman. The garnets, properly so called, contain a greater quantity of siliceous earth than the shirls, and both are now justly ranked with the siliceous earths.

The species are,

I. Garnet; *Granatus.*

This is a heavy and hard kind of stone, crystallising in form of polygonal balls, and mostly of a red, or reddish brown colour.

A. Garnet mixed with iron; *Granatus martialis.*

1. Coarse-grained garnet-stones, without any particular figure; in Swedish called *Granatberg*; in German, *Granatstein*.

a. Reddish-brown garnet. b. Whitish-yellow. c. Pale yellow.

2. Crystallised garnet.

a. Black. b. Red: semi-transparent, and cracked; transparent. c. Reddish-yellow; transparent; the jacinth, or hyacinth. d. Reddish brown. e. Green. f. Yellowish-green. g. Black.

B. Garnet mixed with iron and tin.

1. Coarse-grained, without any particular figure.

a. Blackish-brown.

2. Crystallised.

a. Blackish-brown.

b. Light-green or white.

C. Garnet mixed with iron and lead.

1. Crystallised.

a. Reddish-brown.

II. Cockle, or shirl. *Corneous crystallisatus Wallerii*; *Stannum crystallis columnaribus nigris Linnæi.*

This is a heavy and hard kind of stone which shoots into crystals of a prismatical figure, and whose chief colours are black or green. Its specific gravity is the same as the garnets, viz. between 3000 and 3400, though always proportionable to their different solidity.

A. Cockle, or shirl, mixed with iron.

1. Coarse, without any determined figure.

a. Green,

2. Sparry.

a. Deep green, (the mother of the emeralds), from Egypt.

b. Pale green.

c. White. This occurs very frequently in the scaly limestones; and its colour changes from deep green to white, in proportion as it contains more or less of iron.

3. Fibrous, striated cockle, or shirl: it looks like fibres or threads made of glass.

A. Of parallel fibres. a. Black. b. Green. c. White.

B. Of concentrated fibres: The starred cockle, or shirl, from its fibres being laid stellarwise.

a. Blackish green. b. Light green. c. White.

4. Crystallised cockle, or shirl.

a. Black. To this variety belong most of those substances called *imperfect asbesti*; and as the cockle perfectly resembles a slag from an iron furnace, both in regard to its metallic contents and its glassy texture, it is no wonder that it is not soft enough to be taken for an asbestus. It has, however, only for the sake of its structure, been ranked among the asbesti. The striated cockle, or shirl, compared to the asbesti, is of a shining and angular surface (though this sometimes requires the aid of the magnifying-glass to be discovered), always somewhat transparent, and is pretty easily brought to a glass with the blow-pipe, without being consumed as the pure asbesti seem to be.

b. Deep green.

c. Light green.

d. Reddish brown. The *tauffstein* is of this colour, and consists of two hexagonal crystals of cockle grown together in form of a cross; this the Roman Catholics wear as an amulet, and is called in Latin *lapis crucifer*, or the cross stone.

The figure of the cockle crystals is uncertain, but always prismatical: the cockle from Yxlio at Nya Kopparberg, is quadrangular: the French kind has nine sides or planes; and the *tauffstein* is hexagonal.

The name *cockle* for these substances is an old Cornish mineral name; but is also given sometimes to other very different matters.

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We have not in England any great quantity of species of cockles; the chief are found in the tin mines of Cornwall, and some fine crystallised kinds have been brought from Scotland.

The English mineral name of *call*, has been used by some authors as synonymous with *cockles*, and they are confounded together at the mines; but the call, definitely speaking, is the substance called *wolfram* by the Germans, &c.

Garnets, though small, are often found in micaceous stones in England; but extreme good garnets are found in great plenty also in like stones in Scotland.

III. Rowley rag, (*Kirwan*.) This stone is of a dusky or dark grey colour, with numerous minute shining crystals. Its texture is granular: by exposure to the air it acquires an ochry crust. Its specific gravity is 2748. Heated in an open fire it becomes magnetic. In strong heat it melts *per se*, but with more difficulty than basalt. According to Dr Withering's analysis, 100 parts of it contain 47,5 of siliceous earth, 32,5 of argil, and 20 of iron.

IV. Siliceous muriatic spar, (*Id.*) This stone is of a hard, solid, and sparry texture; of a grey, ochry, dull colour, but internally bright. It gives fire with steel: yet it effervesces with acids. In a strong heat it grows brown; but at last it melts *per se*. One hundred parts of this stone contain fifty parts of silex: the remainder is mild magnesia and iron; but in what proportion is not mentioned (See *Journal de Physique*, Supplement, vol. xiii. p. 216.)

V. Turkey stone; *cos Turcica*, (*Id.*) This stone is of a dull white colour, and often of an uneven colour, some parts appearing more compact than others, so that it is in some measure shattery. It is used as a whetstone: and those of the finest grain are the best hones for the most delicate cutting tools, and even for razors, lancets, &c. Its specific gravity is 2598. It gives fire with steel; yet effervesces with acids. Mr Kirwan found that 100 parts of it contains 25 of mild calcareous earth, and no iron. There probably are two sorts of stones known by this name, as Mr Wallerius affirms, that which he describes neither to give fire with steel nor effervesce with acids.

VI. Ragg stone. The colour of this stone is grey. Its texture is obscurely laminar, or rather fibrous, but the laminae or fibres consist of a congeries of grains of a quartz appearance, coarse and rough. Its specific gravity is 2729. It effervesces with acids; and gives fire with steel. Mr Kirwan found it to contain a portion of mild calcareous earth, and a small proportion of iron. It is used as a whet-stone for coarse cutting tools.

[The siliceous grit, *cos arenarius*, and other compounds of the siliceous earth, &c. will be found in a subsequent division of this article.]

Observations on the economical Uses of the Siliceous Order.

THE Europeans have no farther trouble with the precious stones than either to cut them from their natural or rough figure, or to alter them when they have been badly cut in the East Indies; in which latter cir-

cumstances they are called *labora*: and it may be observed, that for cutting the ruby, spinell, ballas, and chrysolite, the oil of olive is required, instead of any other liquid, to be mixed with the diamond powder, in the same manner as for cutting the diamond itself.

If the petty princes in those parts of the Indies, where precious stones are found, have no other power nor riches proportionable to the value of these gems, the reason of it is as obvious as of the general weakness of those countries where gold and silver abound, viz. because the inhabitants, placing a false confidence in the high value of their possessions, neglect useful manufactures and trade, which by degrees produces a general idleness and ignorance through the whole country.

On the other hand, perhaps, some countries might safely improve their revenues by such traffic. In Saxony, for example, there might probably be other gems found besides aqua marines and topazes; or even a greater trade carried on with these than at present, without danger of bad consequences, especially under the direction of a careful and prudent government.

The *half-precious* stones, so called, or gems of less value, as the common opal, the onyx, the chalcedony, the cornelian, and the coloured and colourless rock crystals, have been employed for ornaments and economical utensils, in which the price of the workmanship greatly exceeds the intrinsic value of the stones. The ancients used to engrave concave and convex figures on them, which now-a-days are very highly valued, but often with less reason than modern performances of the same kind. These stones are worked by means of emery on plates and tools of lead, copper, and tin, or with other instruments; but the common work on agates is performed at Oberstein with grind-stones at a very cheap rate. When once such a manufactory is established in a country, it is necessary to keep it up with much industry and prudence, if we would wish it to surmount the caprice of fashions; since, howmuchsoever the natural beauties of these stones seem to plead for their pre-eminence, they will at some periods unavoidably sink in the esteem of mankind; but they will likewise often recover, and be restored to their former value.

The grindstones at Oberstein are of a red colour, and of such particular texture, that they neither become smooth, nor are they of too loose a composition.

Most part of the flinty tribe is employed for making glass, as the quartz, the flints, the pebbles, and the quartzose sands. The quartz, however, is the best; and if used in due proportion with respect to the alkali, there is no danger of the glass being easily attacked by the acids, as has sometimes happened with glass made of other substances, of which we had an instance of bottles filled with Rhenish and Moselle wines during the time of a voyage to China.

In the smelting of copper ores, quartz is used, to render the slag glassy, or to vitrify the iron; quartz being more useful than any other stone to prevent the calcination of the metal.

The quartzose sand which constitutes part of many stones, and is also used in making crucibles and such vessels,

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Argillaceous vessels, contributes most of all to their power of resisting fire.

It appears likewise probable that the quartzose matter makes the grind and whetstone fit for their intended purposes. (*Magellan.*)

Order V. The ARGILLACEOUS EARTHS.

THE principal character whereby those may be distinguished from other earths is, that they harden in the fire, and are compounded of very minute particles, by which they acquire a dead or dull appearance when broken.

I. *Argilla aerata*; *lac luna*.

This fanciful name was heretofore thought to denote a very fine species of calcareous earth; but Mr Sreber has lately shown, that the earth to which this name is given, is a very uncommon species of argill. It is generally found in small cakes of the hardness of chalk; and like that, it marks white. Its hardness is nearly as that of steatites, and it does not feel so fat as common clay does. Its specific gravity is 1669; its colour snow white. When examined with a microscope, it is found to consist of small transparent crystals; and by his experiments it appears plainly to be an argill saturated with fixed air. It effervesces with acids, and contains a very small proportion of calcareous earth and sometimes of gypsum, besides some feeble traces of iron. It is found near Halles.

II. Porcelain clay; *Terra porcellanea*, vulgo *Argylla apyra*, very refractory; the *kaolin* of the Chinese.

(1.) Pure.

A Diffusible in water.

1. Coherent and dry.
 - a White.
2. Friable and lean.
 - a. White.

(2.) Mixed with phlogiston

A. Diffusible in water.

- a. White and fat pipe clay. b. Of a pearl colour.
- c. Bluish grey. d. Grey. e. Black. f. Violet.

These contain a phlogiston, which is discovered by exposing them to quick and strong fire, in which they become quite black interiorly, assuming the appearance of the common flints, not only in regard to colour, but also in regard to hardness; but if heated by degrees, they are first white, and afterwards of a pearl colour. The fatter they seem to be, which may be judged both by their feeling smooth and unctuous, and by their shining when scraped with the nail, they contain a larger quantity of the inflammable principle. It is difficult to determine, whether this strongly inherent phlogiston be the cause of the above-mentioned pearl-colour, or prevents them from being burnt white in a strong fire; yet no heterogeneous substance can be extracted from them, except sand, which may be separated from some by means of water; but which sand does not form any of the constituent parts of the clays. If they be boiled in aqua regis in order to extract any iron, they are found to lose their viscosity.

III. Stone-marrow; *Lithomarga*. *Keffekil* of the Tartars.

1. When dry, it is as fat and slippery as soap; but,

2. Is not wholly diffusible in water, in which it only falls to pieces, either in larger bits, or resembles a curd-like mass.

3. In the fire it easily melts to a white or reddish frothy slag, consequently is of a larger volume than the clay was before being fused.

4. It breaks into irregular scaly pieces.

A. Of coarse particles: Coarse stone-marrow.

a. Grey.

b. Whitish yellow, from the Crim Tartary, where it is called *keffekil*, and is said to be used for washing instead of soap.

B. Of very fine particles; fine stone-marrow.

a. Yellowish brown; *Terra Lemnia*.—Is of a shining texture, falls to pieces in the water with a crackling noise; it is more indurated than the preceding, but has otherwise the same qualities.

IV. Bole, (iron clay.)

This is a fine and dense clay of various colours, containing a great quantity of iron, which makes it impossible to know the natural and specific qualities of the bole itself, by any easy method hitherto in use. It is not easily softened in water, contrary to what the porcelain and the common clays are, (I. & VI.); but either falls to pieces in form of small grains, or repels the water, and cannot be made ductile. In the fire it grows black, and is then attracted by the loadstone.

A. Loose and friable boles, or those which fall to a powder in water.

a. Flesh-coloured bole.

b. Red.

1. Fine; *Bolus Armenus*.
2. Coarse; *Bolus communis officinalis*.
3. Hard: *Terra rubrica*.

c. Green; *Terre verte*.

1. Fine.

2. Coarse.

d. Bluish-grey, is ductile as long as it is in the rock, but even then repels the water; it contains 40 per cent. of iron; which metal being melted out of it in a close vessel, the iron crystallises on its surface.

e. Grey.

1. Crystallised in a spherical polygonal figure.

2. Of an undeterminate figure.

B. Indurated bole.

A. Of no visible particles.

This occurs very often in form of slate, or layers, in the earth; and then is made use of as an iron ore. However, it has usually been considered more in regard to its texture than to its constituent parts; and has been called *slate*, in common with several other earths which are found to have the same texture.

a. Reddish-brown; in most collieries, between the seams of coal.

b. Grey.

B. Of scaly particles.—The *hornblende* of the Swedes.

It is distinguished from the martial glimmer, or mica, by the scales being less shining, thicker, and rectangular.

- a. Black.—This, when rubbed fine, gives a green powder.
- b. Greenish.

V. Zeolyte.

This is described in its indurated state in the Transactions of the academy of sciences at Stockholm for the year 1756, and there arranged as a stone *sui generis* in regard to the following qualities.

1. It is a little harder than the fluors and the other calcareous spars; it receives, however, scratches from the steel, but does not strike fire with it.
2. It melts easily by itself in the fire, with a like ebullition as borax does, into a white frothy slag, which cannot without great difficulty be brought to a solidity and transparency.
3. It is more easily dissolved in the fire by the mineral alkali (*sal soda*), than by borax or the microcosmic salt.
4. It does not ferment with this last salt, as lime does; nor with the borax, as those of the gypseous kind.
5. It dissolves very slowly, and without any effervescence, in acids, as in oil of vitriol and spirit of nitre. If concentrated oil of vitriol be poured on pounded zeolites, a heat arises, and the powder unites into a mass.
6. In the very moment of fusion it gives a phosphoric light.

There have lately been discovered some of the zeolites, particularly at Adelfors's gold mines in Smoland, in Sweden; of which some sorts do not melt by themselves in the fire, but dissolve readily in the acid of nitre, and are turned by it into a firm jelly.

The zeolyte is found in an indurated state:

- (1.) Solid, or of no visible particles.
 - A. Pure.
 - a. White.
 - B. Mixed with silver and iron.
 - a. Blue, *Lapis lazuli*.
- (2.) Sparry zeolite. This resembles a calcareous spar, though it is of a more irregular figure, and is more brittle.
 - a. Light red, or orange-coloured.
- (3.) Crystallised zeolite. This is more common than the two preceding kinds; and is found,
 - A. In groupes of crystals, in form of balls, and with concentric points.
 - a. Yellow.
 - b. White.
 - B. Prismatical and truncated crystals.
 - a. White.
 - C. Capillary crystals, which are partly united in groupes, and partly separate. In this latter accretion they resemble the capillary or feathery silver ore; and are perhaps sometimes called *flos ferri*, at places where the nature of that kind of stone is not yet fully known.
 - a. White.

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VI. Tripoli.

This is known by its quality of rubbing or wearing hard bodies, and making their surfaces to shine; the particles of the tripoli being so fine as to leave even no scratches on the surface. This effect, which is called *polishing*, may likewise be effected by other fine clays when they have been burnt a little. The tripoli grows somewhat harder in the fire, and is very refractory: it is with difficulty dissolved by borax, and still with greater difficulty by the microcosmic salt. It becomes white when it is heated: when crude, it imbibes water, but is not diffusible in it: it tastes like common chalk, and is rough or sandy between the teeth, although no sand can by any means be separated from it. It has no quality common with any other kind of earth, by which it might be considered as a variety of any other. That which is here described is of a yellow colour, and is sold by druggists. This kind of tripoli has been lately discovered in Scotland. But the *rotten-stone*, so called, is another sort found in England, viz. in Derbyshire. It is in common use in England among workmen for all sorts of finer grinding and polishing, and is also sometimes used by lapidaries for cutting of stones, &c.

The tripoli is found,

1. Solid: of a rough texture.
 - a. Brown.
 - b. Yellowish.
 - c. Spotted like marble.
2. Friable and compact.
 - a. Granulated.
 - b. Brown.
 - c. Yellowish.

VII. Common clay, or brick clay.

This kind may be distinguished from the other clays by the following qualities:

1. In the fire it acquires a red colour, more or less deep.
2. It melts pretty easily into a greenish glass.
3. It contains a small quantity of iron and of the vitriolic acid, by which the preceding effects are produced.

It is found,

- A. Diffusible in water.
 1. Pure.
 - a. Red clay.
 - b. Flesh-coloured, or pale-red.
 - c. Grey.
 - d. Blue.
 - e. White.
 - f. Fermenting clay.
 2. Mixed with lime. See MARLE, above.
- B. Indurated.
 1. Pure.
 - a. Grey slaty.
 - b. Red slaty.
 2. Mixed with phlogiston, and a great deal of the vitriolic acid. See ALUM Ores, above.
 3. Mixed with lime. See LIME, above.

VIII. Argillaceous fissile stones.

These and many other different kinds of earth have been comprehended under the denomination

of *schist*; but to avoid ambiguity we will confine this name to stones of the argillaceous kind.

1. The bluish purple schistus, or common roof slate; *schistus tegularis*.

Its colour varies to the pale, to the slightly purple, and to the bluish.

- a. The dark-blue slate, *schistus scriptorius*.

2. The pyritaceous schistus.

This is of a grey colour, brown, blue, or black.

3. The bituminous schistus.

This is generally black, of a lamellar texture, and of different degrees of hardness.

4. Flag stone.

This is of a grey, yellowish, or reddish white colour.

5. The argillaceous grit.

This is called also *sand stone* and *free stone*, because it may be cut easily in all directions.

6. Killas.

This stone is of a pale grey or greenish colour; either lamellar, or coarsely granular. It is found chiefly in Cornwall.

7. Toadstone.

Dr Withering, who has given an analysis of this stone, describes it as being of a dark brownish grey colour, of a granular texture, not giving fire with steel, nor effervescing with acids. It has cavities filled with crystallised spar, and is fusible *per se* in a strong heat. It is found in Derbyshire. See TOADSTONE.

For the æconomical uses of the argillaceous earths, see the article CLAY.

[The compounds of this and other earths will fall to be mentioned under a subsequent division.]

CLASS II. SALTS.

By this name those mineral bodies are called which can be dissolved in water, and give it a taste; and which have the power, at least when they are mixed with one another, to form new bodies of a solid and angular shape, when the water in which they are dissolved is diminished to a less quantity than is required to keep them in solution; which quality is called *crystallisation*.

In regard to the principal known circumstances or qualities of the mineral salts, they are divided into

1. Acid salts, or mineral acids.
2. Alkaline salts, or mineral alkalies.

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Order I. ACID SALTS.

For the characters, properties, and phenomena of these, see the article ACID, and CHEMISTRY-Index.

Till of late no more mineral acids were known than the vitriolic and marine; the boracic or sedative salt being reckoned as produced artificially: but later discoveries have proved that we may reckon at least *eleven mineral acids*; out of which only two or three have been found in an uncombined state. Those hitherto known are the following, viz. the *vitriolic*, the *nitrous*, the *marine*, the *sparry*, the *arsenical*, the *molybdenic*, the *tungstenic*, the *phosphoric*, the *boracic*, the *fucinous*, and the *aerial*. See the article ACID, and CHEMISTRY-Index.

- I. The vitriolic acid. See CHEMISTRY-Index.

- II. Nitrous acid.

This acid is by some excluded from the mineral kingdom, because they suppose it to be produced from putrefaction of organic bodies. But these bodies, when deprived of life, are again received amongst fossils, from whence their more fixed parts were originally derived. For the nature of this acid, see CHEMISTRY-Index.

- III. Acid of common or sea-salt. See CHEMISTRY-Index, at *Acid* and *Marine*.

- IV. The fluor acid, or sparry fluor acid. See CHEMISTRY-Index.

This acid is obtained by art, as it has never been found disengaged, but united, to calcareous earth, forming a sparry fluor*, called *Derbyshire fluor*, *Cornish fluor*, *blue John*, or *amethyst root*, ^{Star} when of a purple colour. See p. 72. col. 2. concerning the substances arising from the combination of this acid with calcareous earth.

- V. The acid of arsenic. See CHEMISTRY-Index.

- VI. The acid of molybdena. *Ibid.*

- VII. The acid of tungsten. *Ibid.*

- VIII. The phosphoric acid. *Ibid.*

- IX. The boracic acid. *Ibid.*

- X. The fucinous or amber acid. *Ibid.*

- XI. Aerial acid, or fixed air. *Ibid.*

Order II. ALKALINE MINERAL SALTS.

For the characters, properties, and phenomena of these, see the article ALKALI; also CHEMISTRY-Index, at *Alkali* and *Alkalies*.

New acids are daily detected; but no additions have been made to the three species of alkali long since known.

These alkaline salts are,

- I. Vegetable fixed alkali (A.)

M

Vegetable

(A) With regard to the origin of the vegetable fixed alkali, there are sufficient proofs that it exists already formed in plants, and also that a portion is formed by combustion; but in each case, the alkali is obtained in an impure state through the admixture of other matters, which must be separated before it can be used for chemical purposes.

The *cendres gravelées* are made by burning the husks of grapes and wine lees. They contain the purest alkali met with in common, and are used by the dyers.

Pot-ash is made by burning wood and other vegetables. This alkali is much phlogificated, and contains many foreign and saline matters, which, however, may be separated.

That which is obtained from the ashes of wood burned in kitchens is the most pure of all. On the contrary,

Vegetable fixed alkali, deprived of every acid, is not found any where by itself; but it is sometimes met with in combination with the vitriolic acid or the muriatic, generally with the nitrous, rarely with the aerial (B.)

The fixed vegetable alkali (or *potasse* of Morveau), is of a powdery appearance, and of a dead white colour. When pure, it is much more caustic than the neutral salt; it forms with the aerial acid, and even corrodes the skin (C.)

1. It changes the blue colours of vegetables into a deep green.
2. It has no smell when dry; but when wetted, it has a slight lixivious odour.
3. Its taste is strongly acrid, burning, caustic, and urinous (D). This last sensation arises from the volatile alkali it disengages from animal substances.
4. When exposed to the air, it attracts humidity, and is reduced into a transparent colourless liquor. According to Gellert, it attracts three times its own weight of water.
5. It likewise attracts sometimes the aerial acid from the atmosphere, and is thereby deprived of its property of deliquescing.
6. When it is dissolved in an equal weight of water, it has an oily feel, owing to its action on the fatty parts of the skia, whence it is, though improperly, called *oil of tartar*.
7. In a moderate heat it melts; but in a more violent fire, it is dispersed or volatilized.
8. It is a most powerful solvent by the dry way: in a proper heat, it dissolves calcareous, argillaceous, siliceous, and metallic earths: and when the alkali is nearly equal in quantity to the earth, it forms various kinds of hard, solid, and transparent glass.
9. But if the alkali be in quantity three or four times that of the earth, the glass is deliquescent.
10. The mild vegetable alkali unites with the vitriolic acid with a violent effervescence, and produces vitriolated tartar.

11. With the nitrous acid, it forms the crystallizable salt, called *nitre*.

12. With the marine acid it forms a kind of salt less grateful than common salt, which is called the *febrifuge salt of Sylvius*.

13. With vinegar it forms a neutral deliquescent salt of a sharp taste, called *terra foliata tartari*.

14. With cream of tartar it forms tartarized tartar.

15. It dissolves sulphur, and forms the substance called *liver of sulphur*, which is a powerful solvent of metallic substances.

16. It attracts the metals, and dissolves some of them with peculiar management. Silver, mercury, and lead, are more difficultly dissolved than gold, platina, tin, copper, and especially iron. The last gives a fine reddish saffron colour, first observed by Stahl, who called it the *martial alkaline tincture*.

17. It dissolves in the dry way all the dephlogisticated metallic calces.

18. It unites with oils and other fat substances, with which it forms soap.

19. This alkali becomes opaque when exposed to the flame of the blow-pipe: it decrepitates a long time, and forms a glassy button, which is permanent in the little spoon; but is absorbed with some noise on the charcoal when blown upon it.

II. Fossile fixed alkalis.

A. Alkali of the sea, or of common salt (E.)

1. Pure.

This has nearly the same qualities with the lixivious salt, which is prepared from the ashes of burnt vegetables. It is the same with the *sal soda*, or kelp: for the kelp is nothing else than the ashes remaining, after the burning of certain herbs that abound in common salt; but which common salt, during the burning of those vegetables, has lost its acid (F).

The properties of the fossile alkali are as follows:

1. It

trary, that which is got from tartar, properly burned, then dissolved in boiling water, and purified by filtration and crystallisation, is called *salt of water*. It is the best.

(B) The vegetable alkali is seldom found in the earth, except in wells of towns, as at Doway, or in the argillaceous alum-ore of la Tolfa: it is found also united to the nitrous acid, near the surface of the earth, in Spain and in the East-Indies, probably from the putrefaction of vegetables.

(C) Common vegetable alkali, salt of tartar, and pot-ash, were formerly considered by chemists as simple alkalis; but Dr Black has demonstrated them to be true neutral salts, arising from the combination of the vegetable alkali with the aerial acid. From hence it follows, that the above common alkalis, even after any other extraneous substance has been extracted, must be freed from this acid, by putting each in a crucible, and exposing it to a strong fire, which will dissipate this aerial acid. The alkali so purified, is to be put in a glass vial before it be entirely cold, and kept close with a proper stopple; otherwise the aerial acid which floats in large quantities on the atmosphere will combine again with the pure alkali. (*Mongez*.)

(D) The alkali must be largely diluted with water, in order to be tasted; otherwise it will act on the tongue, and corrode the parts where it touches. (*Macquer*.)

(E) This salt is not met with pure in Europe; but it is said to be found in both the Indies, not only in great quantity, but likewise of a tolerable purity: it is there collected in form of an efflorescence in the extensive deserts, a profitable trade being carried on in it for the making of soap and glass; and, therefore, it is very probable that the ancients meant this salt by their *natron* or *baurach*. (*Magellan*.)

(F) The mineral alkali is often combined with the vitriolic and marine acid, and also with the aerial acid;

1. It effervesces with acids, and unites with them.
2. Turns the syrup of violets to a green colour.
3. Precipitates sublimate mercury in an orange-coloured powder.
4. Unites with fat substances, and forms soap.
5. Dissolves the siliceous earth in the fire, and makes glass with it, &c. It distinguishes itself from the salt of the pot-ashes by the following properties (G).
6. It shoots easily into rhomboidal crystals; which
7. Fall to powder in the air, merely by the loss of their humidity (H).
8. Mixed with the vitriolic acid, it makes the *sal mirabile Glauberi*.
9. It melts more easily, and is fitter for producing the *sal commune regeneratum, nitrum cubicum*, &c. Perhaps it is also more conveniently applied in the preparation of several medicines.

8

10. It is somewhat volatile in the fire.

III. Volatile mineral alkali.

This perfectly resembles that salt which is extracted from animals and vegetables, under the name of *alkali volatile*, or *sal urinosum*, and is commonly considered as not belonging to the mineral kingdom; but since it is discovered, not only in most part of the clays, but likewise in the sublimations at Solfatara, near Naples, it cannot possibly be quite excluded from the mineral kingdom (1).

Its principal qualities are,

- a. In the fire it rises in *forma sicca*, and volatiles in the air in form of corrosive vapours, which are offensive to the eyes and nose (K).
- b. It precipitates the solution of the mercurial sublimate in a white powder.
- c. It also precipitates gold out of aqua-regia, and detonates with it; because,
- d. It has a re-action in regard to the acids, tho' not so strongly as other alkalies.

M 2

e. It

acid; with which last it retains not only the name but many of the properties of a pure alkali, because this last acid is easily expelled.

It is easily known by its crystallisation and its solubility in two times and an half of its weight of water, at the temperature of 60 degrees.

One hundred parts of this alkali, when pure and recently crystallised, contain 20 of mere alkali, 16 of aerial acid, and 64 of water. (*Macquer*.)

Mineral alkali is found in Hungary, in marshy grounds, of an argillaceous or marly nature, either mixed with water or crystallised and efflorescing. It is found also in Egypt at the bottom of lakes, and dried up by the summer's heat; and also in the province of Suchena, 28 days journey from Tripoli, where it has the name of *Trona*; in Syria, Persia, as well as in the East-Indies, and China, where it is called *kien*. It sometimes germinates on walls, and is called by many *aphronitron*. In its native state, is frequently mixed with magnesian earth, common salt, muriatic magnesia, and marine selenite. (*Kirwan*.)

(G) This mineral alkali likewise differs from the vegetable, 1. By its taste, which is less corrosive and burning. 2. By its not deliquescent. 3. By the small degree of heat it produces if calcined, and afterwards added to water. 4. By its property of crystallising, by evaporating the water from its solution, as is practised with neutral salts; whereas the vegetable alkali does not crystallise unless combined with a large portion of aerial acid.

(H) This alkali being a very useful commodity, and essentially necessary in a number of manufactories, many ingenious processes have been contrived and attempted to procure it at a cheap rate, by decomposing the sea-salt; but it is believed, that till lately none of these new manufactures have succeeded, except that of Mr Turner, mentioned by Mr Kirwan in the second part of the Philosophical Transactions for 1782.—The process is said to consist in mixing a quantity of litharge with half its weight of common salt, which, on being triturated with water till it assumes a white colour, is left to stand some hours; after which, a decomposition ensues, the alkali being left alone, whilst the acid unites to the metallic calx; and this last being urged by a proper degree of fire, produces a fine pigment of a greenish yellow colour, whose sale pays for the most part of the expences.

Mr Kirwan says, in the place already quoted, that if common salt perfectly dry be projected on lead heated to incandescence, the common salt will be decomposed, and a horn-lead formed, according to Margraaf. He adds also, that according to Scheele, if a solution of common salt be digested with litharge, the common salt will be decomposed, and a caustic alkali produced; and, finally, that Mr Scheele decomposed common salt, by letting its solution slowly pass through a funnel filled with litharge.

(1) It is easily known by its smell, though in a mild state, by its volatility, and by its action on copper; the solutions of which, in the mineral acids, are turned blue by an addition of this alkali. It is frequently found, though in small quantities, in mould, marl, clay, schistus, and in some mineral waters. It probably derives its origin, in the mineral kingdom, from the putrefaction or combustion of animal or vegetable substances. (*Kirwan*.)

The same is caustic when uncombined with any acid, not excepting even the aerial acid. It differs from the other two alkalies in many essential particulars. 1. By its aeriform or gaseous nature. For the volatile alkali, in a state of purity, is nothing more than an alkaline gas diffused in water, as Dr Priestley has demonstrated. 2. By its volatility. 3. By the nature of the salts it forms with acids, which are very different from those whose bases are formed either of the vegetable or mineral alkali. (*Mongez*.)

(K) Pure volatile alkali, in an aerial form, resembles atmospheric air, but is more heavy. Its smell is pene-

- e. It tinges the solution of copper blue, and dissolves this metal afresh if a great quantity is added (L).
f. It deflagrates with nitre, which proves that it contains a phlogiston.
It is never found pure.

Order III. NEUTRAL SALTS.

Acids united to alkalies form neutral salts. These dissolved in water are no ways disturbed by the addition of an alkali; and generally, by evaporation, concrete into crystals. If, by proper tests, they show neither acid nor alkaline properties, they are said to be perfect neutrals; but imperfect, when, from defect in quantity or strength of one ingredient, the peculiar properties of the other more or less prevail.

- I. Vitriolated tartar, vitriolated vegetable alkali, or (as Morveau calls it) the *vitriol of pot-ash*.

This is a perfectly neutral salt, which results from the combination of the vitriolic acid with the vegetable fixed alkali. According to Bergman, it seldom occurs spontaneously in nature, unless where tracks of wood have been burnt down: and Mr Bowles, quoted by Mr Kirwan, says it is contained in some earths in Spain. See CHEMISTRY-Index.

It is easily obtained, by pouring the vitriolic acid on a solution of fixed vegetable alkali till it is saturated. Crystals of this neutral salt are then formed. This crystallisation succeeds better by evaporation than by cooling, according to Mongez.

The taste of this salt is disagreeable, though somewhat resembling common salt.

- II. Common nitre, (*Alkali vegetabile nitratum*).

This is known in commerce by the name of *salt-petre*, and is also called *prismatic nitre*, to distinguish it from the cubic nitre after-mentioned.—It is perfect neutral salt; resulting from the combination of the nitrous acid with the pure vegetable alkali.

According to Bergman, it is formed upon the surface of the earth, where vegetables, especially when mixed with animal-substances, putrify.—See CHEMISTRY-Index, at *Nitre*.

- III. Digestive salt, salt of Sylvius, (*Alkali vegetabile salinum*).

This neutral salt is sometimes, though rarely, met

with on the earth, generated perhaps, as professor Bergman observes, by the destruction of animal and vegetable substances.

According to Macquer, this salt has been very wrongly called *regenerated marine salt*; and the epithet of *febrifug* has also been given to it, without any good reason, to evince that it has such a property. But M. de Morveau calls it *mariate de potasse* with great propriety.

This salt is produced by a perfect combination of the vegetable alkali with marine acid. It has been wrongly confounded with common salt.—It is found in some bogs in Picardy, and in some mineral waters at Normandy, according to Monnet, quoted by Kirwan. Mongez adds also the sea-water, as containing this salt, and that it is never found in large quantities, although its components parts are abundantly produced by nature. See CHEMISTRY-Index, at *Digestive*.

- IV. Mild vegetable alkali, (*alkali vegetabile aeratum*).

This salt was formerly considered as a pure alkali, known by the name of *potash* and *salt of tartar*: but since the discovery of the aerial acid, it is very properly classed among the neutral salts, and ought to be called *aerated potash*.

It results from a combination of the vegetable alkali with the aerial acid, and is hardly ever found native, unless in the neighbourhood of wood, destroyed by fire.

On being exposed on a piece of charcoal, urged by the blow-pipe, it melts, and is absorbed by the coal; but,

In the metallic spoon, it forms a glassy bead, which becomes opaque when cold.

- V. Vitriolated acid saturated with mineral alkali; Glauber's salt. *Alkali minerale vitriolatum*.

This is a neutral salt, prepared by nature (as well as by art), containing more or less of iron, or of a calcareous earth; from which arises also some difference in its effects when internally used. It shoots easily into prismatical crystals, which become larger in proportion to the quantity of water evaporated before the crystallisation. When laid on a piece of burning charcoal, or else burnt with a phlogiston, the vitriolic acid discovers itself by the smell resembling the hepar sulphuris.

It is found in a dissolved state in springs and wells. Some of the lakes in Siberia and Altran-

penetrating, and suffocates animals. Its taste is acrid and caustic. It quickly converts blue vegetable colours to green, and produces heat during its combination with water. But if the water be frozen, it melts, producing at the same time an extreme degree of cold. It has a remarkable action on most metals, particularly copper.

This substance is obtained by the putrefactive fermentation from animal and some vegetable matters. It is this salt which causes that strong smell which is perceived in drains and privies on a change of weather. (Mongez.)

Its volatility arises from a very subtle and volatile (or phlogistic) oil, which enters as a principle into its composition. (Macquer.)

(L) The solution of copper by this alkali, which is of a fine blue, presents a remarkable phenomenon. For if it be kept in a well closed phial, the colour decays, and at length disappears, giving place to transparency. But on opening the phial, the surface or part in contact with the air becomes blue, and the colour is communicated through the whole mass. This experiment may be many times repeated with the same success.

ean, and many springs in other places, contain this salt, according to Bergman. It is found in the sea-water; also in the earth, at several parts of Dauphiné in France, and in Lorraine; and sometimes it germinates on the surface of the earth, according to Mouet, quoted by Kirwan. It is found, in a dry form, on walls, in such places where aphronitrum has effloresced through them, and the vitriolic acid has happened to be present; for instance, where marcasites are roasted in the open air. This salt is often confounded with the aphronitum or mild mineral alkali.

VI. Cubic or quadrangular nitre. *Alkali minerale nitratum.*

This is the neutral salt which results from the combination of mineral alkali with nitrous acid. It has almost all the characters of prismatic or common nitre, from which it only differs on account of its base; and takes its denomination from the figure of its crystals, which appear cubic.

This salt rarely occurs but where marine plants putrify. According to Bowles, quoted by Kirwan, it is found native in Spain. See CHEMISTRY, n° 741, &c.

VII. Common salt, or sea-salt; *Alkali minerale salitum, sal commune.*

This salt shoots into cubical crystals during the very evaporation; crackles in the fire, and attracts the humidity of the air. It is a perfectly neutral salt, composed of marine acid, saturated with mineral alkali. It has a saline but agreeable flavour. See CHEMISTRY-Index, at Sea-salt.

d. Rock salt, fossil salt; *Sal montanum.* Occurs in the form of solid strata in the earth.

1. With scaly and irregular particles.

a. Grey, and

b. White. These are the most common, but the following are scarcer:

c. Red;

d. Blue; and

e. Yellow, from Cracow in Poland, England, Salzberg, and Tirol.

2. Crystallised rock salt; *sal gemma.*

a. Transparent, from Cracow in Poland, and from Transylvania.

B. Sea-salt.

This is produced also from sea-water, or from the water of salt lakes by evaporation in the sun, or by boiling.

The seas contain this salt, though more or less in different parts. In Siberia and Tartary there are lakes that contain great quantities of it.

C. Spring sea-salt.

This is produced by boiling the water of the fountains near Halle in Germany, and other places.

Near the city of Lidköping, in the province of Westergötland, and in the province of Dal, salt-springs are found, but they contain very little salt: and such weak water is called *solen* by the Swedes.

VIII. Borax.

This is a peculiar alkaline salt, which is sup-

posed to belong to the mineral kingdom, and cannot be otherwise described, than that it is dissoluble in water, and vitrescible; that it is fixed in the fire; and melts to a glass; which glass is afterwards dissoluble in water. See the detached article BORAX.

IX. Mild mineral alkali; *Alkali minerale aeratum.* Natron, the nitre of the ancients.

This neutral salt is a combination of the mineral alkali with the aerial acid or fixed air. It is found plentifully in many places, particularly in Africa and Asia, either concreted into crystallised strata, or fallen to a powder; or efflorescing on old brick walls; or lastly, dissolved in springs. It frequently originates from decomposed common salt.

This is an imperfect neutral salt, and was formerly considered as a pure alkali; but the discovery of the aerial acid has shown the mistake.

1. It has nearly all the properties of the pure mineral alkali N° II. A. 1. (p. 90.), but with less energy.

2. The vegetable blue colours are turned green by this salt; it effloresces with acids, and has an urinous taste.

3. It is soluble in twice its weight of cold water; but if the water is hot, an equal weight is sufficient for its solution.

4. It effloresces when exposed to the action of the atmosphere.

5. It fuses easily on the fire, but without being decomposed.

6. Facilitates the fusion of vitrifiable earths, and produces glass more or less fine according to their qualities.

7. It is decomposable by lime and ponderous earth, which attract the aerial acid.

8. And also by the mineral acids; but these expel the aerial acid of this salt, by seizing its alkaline basis, (*Mongez.*)

Wallerius confounds this salt with the *aphronitrum* after-mentioned, and calls it *halinitrum*, when it contains some phlogiston. Mr Kulbel, quoted by Wallerius, showed that it exists in some vegetable earths, and takes it to be the cause of their fertility; but this (M. Magellan observes) can only be on account of its combination with the oily parts of them, and forming a kind of soap, which is miscible with the watery juices.

X. Vitriolic ammoniac, (*Alkali volatile vitriolatum.*)

This neutral salt was called *secret salt of Glauber*, and is a combination of the volatile alkali with vitriolic acid. According to Bergman, it is scarcely found any where but in places where the phlogisticated fumes of vitriolic acid arise from burning sulphur, and are absorbed in putrid places by the volatile alkali. Thus at Fahlun the acid vapour from the roasted minerals produces this salt in the necessary-houses. Dr Withering, however, observes, that as volatile alkali may be obtained in large quantities from pit-coal, and produced by processes not dependent upon putrefaction, there is reason to believe that the vitriolic ammoniac may be formed in several ways not noticed by the above author.

It is said to have been found in the neighbourhood of volcanoes, particularly of Mount Vesuvius, where, indeed, it might well be expected; yet its existence seems dubious, since Mr Bergman could scarce find any trace of it among the various specimens of salts from Vesuvius which he examined. The reason (according to M. Magellan) probably is, that the vitriolic acid disengaged by the combustion of sulphur is in a phlogisticated state; and all its combinations in this state are easily decomposed by the marine acid, which plentifully occurs in volcanoes. It is also said to be found in the mineral lakes of Tuscany, which is much more probable, as the vitriolic acid when united to water easily parts with phlogiston, and recovers its superiority over other acids. It is said likewise that this neutral salt is found on the surface of the earth in the neighbourhood of Turin.

1. This salt is of a friable texture, and has an acid and urinous taste.
2. Attracts the moisture of the atmosphere.
3. Is very soluble in water, it requiring only twice its weight of cold water, or an equal weight of boiling water, to be dissolved.
4. It becomes liquid on a moderate fire; but if urged,
5. It becomes red hot, and volatilizes.
6. The nitrous and muriatic acid decompose this salt by seizing the volatile alkali. But
7. Lime, ponderous earth, and pure fixed alkali, set the volatile alkali free, and combine with the vitriolic acid.
8. According to Kirwan, 100 parts of this salt contain about 42 of real vitriolic acid, 40 of volatile alkali, and 18 of water.

This vitriolic ammoniac is easily known; for if quicklime or fixed alkali be thrown into its solution, the smell of the volatile alkali is perceived; and if this solution be poured into that of chalk or ponderous earth by the nitrous acid, a precipitate will appear.

XI. Nitrous ammoniac, (*Alkali volatile nitratum*.)

This is a neutral salt, which results from the combination of the nitrous acid with the volatile alkali. It is frequently found in the mother-liquor of nitre. When mixed with a fixed alkali, the volatile betrays itself by its smell.

1. It is of a friable texture, of a sharp bitter, and of a nitrous or cooling taste.
2. According to Mongez, it attracts the moisture of the atmosphere; but Romé de l'Isle asserts, that its crystals are not deliquescent: the experiment may be easily tried, and the truth ascertained.
3. It is soluble in cold water; but half the quantity of water, if boiling, is sufficient for dissolving it.
4. It liquefies on the fire, and afterwards it becomes dry.
5. It detonates with a yellow flame before it is red hot; and what is peculiar to this salt, it needs not, like common nitre, the contact of any combustible matter for its detonation;

from whence it appears that the volatile alkali itself possesses a great share of phlogiston.

6. Its component parts, viz. the nitrous acid and the volatile alkali, are not very intimately united; and of course,
7. It is easily decomposed by all the substances that have any affinity to either of them.
8. Mixed with the muriatic acid it makes aqua regia.
9. One hundred parts of this neutral salt contain 46 of nitrous acid, 40 of volatile alkali, and 14 of water, as Mr Kirwan thinks.

XII. Native sal ammoniac. The muriatic (or marine) acid saturated with a volatile alkali.

This is of a yellowish colour, and is sublimed from the flaming crevices, or fire-springs, at Solfatara, near Naples.

XIII. Aerated or mild volatile alkali.

This neutral salt results from the combination of volatile alkali united to the aerial acid. It was formerly considered as a pure alkali:—But the discovery of the aerial acid (or fixed air) has shown it to be a true neutral salt, though imperfect; as it retains still all the properties of an alkali, though in a weaker degree, on account of its combination with the aerial acid, which is itself the most weak of all acids, and of course other stronger acids easily dislodge it from its base, and from various ammoniacal salts.

1. This imperfect neutral salt has an urinous taste, and a particular smell, which is very penetrating, though less pungent, than the pure volatile alkali; and in the same manner it turns the blue vegetable juices green. But,
2. It effervesces with other acids stronger than the aerial one, which the pure or caustic volatile alkali does not.
3. It sublimes very easily with a small degree of heat;
4. And dissolves in twice its weight of cold water; but in a lesser quantity, when this salt is boiling hot.
5. It acts on metallic substances, chiefly on copper, with which a blue colour is produced.

According to Bergman, this salt was found in a well in London (Phil. Trans. for 1767), at Frankfort on the Mein, and at Lauchstadt.—Messrs. Hierne, Henkel, and Brandt, have found also this salt in the vegetable earth, in various kinds of argil, and in some stony substances. Mr Vozel found it also in some of the incrustations at Gottingen; and Mr Malouin in some acidulous waters of France.

M. Magellan observes, that the borax and the three aerated alkalis are called *imperfect* neutrals; whilst the other neutral salts have acquired the name of *perfect*, because these last do not exhibit any of the distinguishing properties of their component parts. The three aerated alkalis have a very distinct alkaline character, as they turn blue vegetable juices green, though not of so vivid a colour as the caustic alkali

Neutral
SALTS.

alkali does; and the borax is capable of receiving almost an equal quantity of its sedative acid, without losing all its alkaline properties.

In general, those neutral salts, consisting of fixed alkalies combined with acids, are more saturated than those composed of volatile alkali called ammoniacal salts, or those called aerated; which last are only composed by the combination of the aerial acid, united to any alkaline or earthy base.

The aerated alkalis are called also by the name of *mild alkalis*, because they possess no longer that sharp corroding quality which they exhibit when deprived of the aerial acid or fixed air; in which case they are termed caustic alkalis.

These aerated alkalis differ also from the caustic ones, not only on account of the mildness of their taste, from which comes their epithet of mild alkalis, but also by their property of crystallising, and by their effervescing with other acids, which expel the aerial one, the weakest of all acids we know.

Order IV. EARTHY Neutral Salts.

THE compounds of earths and acids which possess solubility are decomposed and precipitated by mild, but not by phlogisticated alkalis.

I. Calcareous earth combined with vitriolic acid.—

Vitriolated calx; Selenite; Gypsum. See p. 72. col. 1. *supra*.

The gypsum, or plaster, is not only found dissolved in various waters, but also in many places it forms immense strata. It is placed by all mineralogists among the earths, which it greatly resembles; but it rather belongs to the saline substances of the neutral kind, as appears by its constituent parts. When burnt, it generates heat with water, but in a less degree than lime does. Berg. Sciag. § 59.

This salt has a particular taste, neither bitter nor astringent, but earthy, when applied to the tongue; and it is owing to it that some waters, chiefly from pumps and wells, are called hard waters, because they lie heavy on the stomach.

It is unalterable whilst kept in a dry place; but on being exposed to a moist air, it is much altered, and suffers a kind of decomposition.

When exposed to fire so as to lose the water off its crystallisation, it assumes a dead white colour; and it is then what we call plaster of Paris; but if the fire is too strong, it melts and vitrifies, after losing the vitriolic acid with which it is saturated. See GYPSUM.

The most famous quarries of gypsum in Europe, are those of Montmartre, near Paris. See *Journal de Physique*; 1780, vol. xvi. p. 289 and 1782, vol. xix. p. 173.

It is found also in the vegetable kingdom.—Mr Model found that the white spots in the root of rhubarb are a selenitical or gypseous earth (*Journal de Phys.* vol. vi. p. 14.)

What is called fossil flour (*farine fossile* in French), generally found in the fissures of rock and gypseous mountains, is very different from the *agaricus mineralis* p. 71. col. 1. and from the *lac lunæ* p. 87. col. 1.; as it is a true gypseous

earth, already described p. 72. col. 1. which, according to Mongez, is of a white and shining colour, though sometimes it assumes a reddish or blueish colour, on account of some martial mixture.

II. Nitre of lime, (*Calx nitrata*.)

This earthy salt is sometimes found in water, but very sparingly. It is said that the chalk hills in some parts of France become spontaneously impregnated with nitrous acid, which may be washed out, and after a certain time they will become impregnated with it again. It is a combination of the nitrous acid with calcareous earth. (*Berg. Sciagr.*)

1. It is deliquescent; and is soluble in twice its weight of cold water, or in an equal weight of boiling water.
2. Its taste is bitter.
3. Is decomposed by fixed alkalies, which form the cubic and the prismatic nitrates.
4. But caustic volatile alkali cannot decompose it.
5. It does not deflagrate in the fire; yet paper moistened with a saturated solution of it crackles in burning.
6. In a strong heat it loses its acid.
7. Its solution does not trouble that of silver in nitrous acid.
8. The vitriolic acid precipitates its basis.
9. As does likewise the acid of sugar.
10. One hundred parts of it contain, when well dried, about 33 of nitrous acid, 32 of calcareous earth, and 35 of water.

It exists in old mortar, and in the mother liquor of nitre; and also in the chalk rocks near Roche Guyon, in France (*Kirwan*.)

III. Muriatic chalk, or fixed salt ammoniac. *Acidum salis communis terra calcarea saturatum*.

This somewhat deliquesces, or attracts the humidity of the air. It is found in the sea water.

It is with great impropriety that this salt has obtained the name of ammoniac, on account only of its being formed in the chemical laboratories during the decomposition of the ammoniacal salt with lime, in the process for making the caustic volatile alkali. In this case, the muriatic acid unites to the calcareous basis, while this last gives its water to the volatile alkali; which, therefore, comes over in a fluid caustic state: but if chalk is employed instead of lime, the volatile alkali receives the aerial acid instead of water, and comes over in a concrete form. In neither case, the new combination of calcareous earth with muriatic salt has any volatile alkali to deserve the name of ammoniacal salt. (*Macquer*.)

1. This earthy salt has a saline and very disagreeable bitter taste. It is supposed to be the cause of that bitterness and nauseous taste of sea-water.
2. It fuses in the fire, and becomes phosphorescent, after undergoing a strong heat.
3. It becomes hard, so as to strike fire with steel.
4. It is then the phosphorus of Homberg.
5. It is decomposable by ponderous earth and fixed alkalis.

6. And also by the vitriolic or nitrous acid; which expel the muriatic acid, to unite with the calcareous basis. (*Mongez.*)
7. Its solution renders that of silver in the nitrous acid turbid, at the same time that
8. It makes no change in that of nitrous selenite.
9. It obstinately retains its acid in a red heat.
10. One hundred parts of this earthy salt contain, when well dried, about 42 of marine acid, 38 of calcareous earth, and 20 of water.
11. It is found in mineral waters, and in the salt works at Saltzburg. (*Kirwan.*)

IV. Aerated chalk, (*Calx aerata.*)

Whenever calcareous earth is over saturated with the aerial acid, it becomes a true earthy neutral salt; becomes soluble in water, and has a slight pungent bitter taste. It is commonly found dissolved in waters, in consequence of an excess of the aerial acid. When this greatly abounds, the water is said to be hard (*cruda*). By boiling or by evaporation, it deposits streaks or crusts of calcareous matter.

But when the calcareous earth is only saturated with the aerial acid without excess, it is not easily soluble; it is then the calcareous spar p. 71. col. 2. and is properly referred to the class of earths, p. 71. col. 1.

V. Vitriolated ponderous earth. *Terra ponderosa vitriolata*; *barytes vitriolata*.

This earthy salt, known by the name of ponderous spar, is a combination of the ponderous earth described in p. 75. col. 1. with the vitriolic acid; and has been already treated of.

The nitrous ponderous earth, according to Bergman, has not yet been found, although it may perhaps exist somewhere, and of course be discovered in nature.

VI. Muriatic barytes, marine baro-selenite. *Barytes salita*.

This earthy salt consists of marine acid united to the ponderous earth. It is said to have been found in some mineral waters in Sweden; and may be known by its easy precipitability with vitriolic acid, and by the great insolubility and weight of this resulting compound, which is the true ponderous spar of the preceding section.

VII. Aerated ponderous earth. *Barytes aerata*.

This earthy neutral salt was found by Dr Withering in a mine at Alstonmore in the county of Cumberland in England. He says that it is very pure, and in a large mass. This substance is a new acquisition to mineralogy, and may be turned to useful purposes in chemistry.

1. It effervesces with acids, and melts with the blow-pipe, though not very readily.
2. In a melting furnace, it gave some signs of fusion; but did not feel caustic when applied to the tongue, nor had it lost its property of effervescing with acids.
3. But the precipitated earth from a saturated solution of it in the marine acid, by the mild vegetable or mineral alkali being burned, and thrown into water, gave it the properties of lime-water, having an acrid taste in a high

N^o 223.

degree: and a single drop of it added to the solutions of vitriolated salts, as the Glauber's salt, vitriolated tartar, vitriolic ammoniac, alum, Epsom salt, selenite, occasioned immediately a precipitation; from whence it appears to be the nicest test to discover the vitriolic acid. By it the marine acid may also be easily freed from any mixture of vitriolic acid, by means of this calx of ponderous earth. See CHEMISTRY, n^o 1049. et seq.

VIII. Vitriolated magnesia.

This earthy neutral salt is called by the English *Epsom salt*; *Sel d'Angleterre* by the French, and also *sel de Sedlitz*, *de Seydshutz*, *sel amer*, *sel cathartique amer*, &c. These various names are given to it, either on account of its properties, it being a very mild purgative; or from the places where it is found, besides many others, as in the waters of Egra, of Creutzbourg, Obermental, Umea, &c. It has also been found native, mixed with common salt and coaly matter, germinating on some free stones in coal mines. See *Kirwan's Mineralogy*, p. 183.

1. It has a very bitter taste.
2. It is soluble in one part and a half of its weight of cold water: but in hot water, a given weight of it dissolves the double of this salt.
3. It effloresces when exposed to a dry atmosphere, and is reduced to a white powder.
4. Exposed to the fire, it loses the water of its crystallization, and is reduced into a friable mass.
5. This earthy salt is decomposed by fixed and volatile alkalies.
6. Lime-water precipitates the magnesia from its solution, the calcareous earth of lime-water combining itself with the vitriolic acid, and forming a selenite. *N. B.* By this test the vitriolated magnesia is easily distinguished from the vitriolated mineral alkali or Glauber's salt which it resembles.
7. But crude chalk, or aerated calcareous earth, has not such an effect in the same case; which shows how much the efficacy of this substance, viz. the calcareous earth, is diminished merely by its union with the aerial acid.
8. When urged by the flame with the blow-pipe, it froths; and may be melted by being repeatedly urged with that instrument.
9. With borax it effervesces, and also when burned with the microcosmic salt.
10. According to Bergman, 100 weight of this salt contains only 19 parts of pure magnesia, 33 of vitriolic acid: and 48 of water. But
11. According to Kirwan, 100 parts of it contain about 24 of real vitriolic acid, 19 of magnesian earth, and 57 of water.

IX. Nitrated magnesia; nitrous Epsom salt.

This earthy salt is usually found together with nitre. It is a combination of the nitrous acid with the magnesian earth.

1. It has an acrid taste, very bitter.
2. Attracts the moisture from the atmosphere, and deliquesces.
3. Is very soluble in water.

4. Is

4. Is easily decomposable by fire.
5. The ponderous and calcareous earths decompose it, and also the alkalies.
6. On being urged by the blow-pipe, it swells up with some noise, but does not detonate.
7. If saturated solutions of nitrous selenite and of this salt be mixed, a precipitate will appear; but,
8. Neither vitriolic acid, nor mild magnesia, will occasion any turbidness in its solution.
9. One hundred parts of this salt contain about 36 of real nitrous acid, 27 of magnesian earth, and 37 of water.

It exists in old mortar, and is found also in the mother liquor of nitre. As lime-water decomposes it, M. de Morveau has indicated the use of this process, not only to complete its analysis; but also to separate, in large quantities, and at a very cheap rate, the magnesian from the calcareous earth, as M. Mongez relates upon this subject.

X. Muriatic magnesia. *Magnesia salita*.

This earthy salt is a combination of magnesian earth with the muriatic acid. According to Bergman, it is found in the sea in greater plenty than any other salt except the sea-salt.

1. It has a very bitter taste: and being always mixed in the sea-water, it is the principal cause of its bitterness.
2. It is very deliquescent, and soluble in a small quantity of water.
3. All the alkalies, even the caustic volatile alkali and lime, decompose it by precipitating its basis.
4. The vitriolic, nitrous, and boracic acids expel the muriatic acid from the base of this neutral salt.
5. Its solution does not trouble that of nitrous or marine selenite; but,
6. It causes a cloud in the nitrous solution of silver.
7. The vitriolic acid throws down no visible precipitate from the solution of this neutral salt.
8. It loses its acid in a red heat.

XI. Aerated magnesia.

Common magnesia, with an excess of aerial acid, is a true neutral salt, like the aerated selenite of p. 96. col. 1. and becomes soluble in cold water. Otherwise it is scarce soluble at all; and is then classed among the earths.

This neutral salt is decomposable by fire, by which its water and its acid are expelled; and it may become phosphoric.

When urged by fire, it agglutinates a little: and some pretended that it melts. But it must be in an impure state to vitrify at all.

The three mineral acids, and the alkalies, dissolve this salt with effervescence, by expelling the aerial acid.

XII. Argillaceous earth combined with vitriolic acid. The *alum* kind. See ALUM, and CHEMISTRY-Index.

- a. With a small quantity of clay; native or plumose alum.

It is found on decayed alum ores in very small

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quantities; and therefore, through ignorance, the alabastrites and selenites, both of which are found among most of the alum slates, are often substituted in its stead, as is also sometimes the asbestos, notwithstanding the great difference there is between the alum and these both in regard to their uses and effects.

- b. With a greater quantity of pure clay; white alum ore.

1. Indurated pale-red alum ore, (*Schistus aluminis Romanus*.) It is employed at Lumini, not far from Civita Vecchia in Italy, to make the pale-red alum called *roch alum*. This is, of all alum ores, the most free from iron; and the reddish earth which can be precipitated from it, does not show the least marks of any metallic substance.

- c. With a very large quantity of martial clay, which likewise contains an inflammable substance: Common alum ore. This is commonly indurated and flaty, and is therefore generally called *alum-slate*.

It is found,

1. With parallel plates, having a dull surface; from Andrarum in the province of Skone, Hunneberg and Billingen in the province of Westergottland, Rodoen in the province of Jemtland, and the island of Oeland, &c. In England, the great alum works at Whitby in Yorkshire are of this kind.
2. Undulated and wedge-like, with a shining surface. This at the first sight resembles pit-coal; it is found in great abundance in the parish of Nas in Jemtland.

XIII. Argillaceous earth saturated with muriatic acid. *Argilla salita*.

Professor Bergman says, that the combinations of the argillaceous earth with the nitrous, muriatic, and aerial acids, had not yet been found naturally formed as far as he knew. But Dr Withering affirms, that he found the muriatic argil to exist in a considerable quantity, in the Nevil Holt water, when he analysed that mineral water about the year 1777: and he adds, that it is probably contained also in the Ballycastle water in Ireland.

XIV. Argillaceous earth mixed with volatile alkali.

[Although this mixture is by no means a neutral salt, this seems to be the place to treat of it according to the order of saline substances adopted in this article.]

The greatest part of the clays contain a volatile alkali, which discovers itself in the distillation of the spirit of sea-salt. &c.

Order V. METALLIC SALTS.

THE native salts belonging to this division may be distinguished by the phlogisticated alkali, which precipitates them all. The few which have saline properties, according to the definition of salts formerly given, shall be mentioned here; referring the rest to the mineralised metals; as the *luna cornea*, the saline quicksilver or muriatic mercury, &c.

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SALTS.

I. Vitriol of copper; blue vitriol. *Vitriolum venteris, seu cyprum.*

This neutral metallic salt is a combination of the vitriolic acid with copper, and is found in all *ziment waters*, as they are called. Its colour is a deep blue; and being long exposed to the air, it degenerates into a rusty yellow blue. Urged by the flame of the blow-pipe on a piece of charcoal, it froths at first with noise, giving a green flame, and the metallic particles are often reduced to a shining globule of copper, leaving an irregularly figured scoria. But with borax the scoria is dissolved, and forms a green glass.

This salt rarely occurs crystallised: but is often found naturally dissolved in water in Hungary, Sweden, and Ireland: from this water a blue vitriol is generally prepared. These natural waters are called *cementatory* or *cementing* ones. According to Monet, this concrete salt, when found naturally formed, only proceeds from the evaporation of such waters. It is also occasionally extracted from sulphurated copper ores after trofaction. See *CHEMISTRY-Index*, at *Vitriol*.

II. Muriatic copper, or marine salt of copper. *Cuprum salitum.*

This salt has been found in Saxony, in the mine of Johngeorgentadt. 1. It is of a greenish colour, and foliated texture. 2. It is moderately hard. 3. Sometimes it is transparent and crystallised.

It has been taken for a kind of mica: but Professor Bergman found it to consist of copper and marine acid, with a little argillaceous earth.

Another specimen of a purer sort was deposited in the museum of Upsal. This is of a bluish green colour, and friable. It effervesces with nitrous acid, to which it gave a green colour: and by adding a proper solution of silver, a *luna cornea* was formed, by which the presence of the muriatic acid was ascertained. (*Kirwan and Bergman*)

III. Martial vitriol; vitriol of iron. Common green vitriol or copperas.

This is the common green vitriol, which is naturally found dissolved in water, and is produced in abundance by decayed or calcined marcasites.

This metallic neutral salt results from the combination of the vitriolic acid with iron.

1. It is of a greenish colour when perfectly and recently crystallised; but,
2. Effloresces by being exposed to the air, becomes yellowish, and is covered with a kind of rust. Sometimes it becomes white by long standing.
3. It requires six times its weight of water, in the temperature of 60 degrees, to be dissolved.
4. It has an astringent, harsh, and acidulous taste.
5. Exposed to a moderate heat, even to that of the sunshine, it falls into a yellowish powder: but,
6. On being exposed to a sudden heat, it melts; and on cooling, assumes a whitish brown colour.
7. When strongly urged by fire, it loses its acid, becomes of a dark red colour, and is then called *colcothar*; a powder which is employed in polishing metals, and to which our artists have

applied the improper name of *crocus maris*, though this name only belongs to the yellow preparations of the iron-calces, used in pharmacy and in enamelling, &c.

Metallie
Neutral
SALTS.

8. Pure fixed alkali precipitates the iron from its solution in deep green flakes; the mild alkali, in a greenish white colour; pure volatile alkali, in so deep a green, that it appears black; but the mild volatile alkali precipitates it in a greyish-green colour.

9. All vegetable astringents, as the tincture of tea, quinquina, gales, &c. precipitate the iron in a black colour: hence they are used as tests to discover its presence in chemical analyses; and it is from this black precipitate that the common writing ink is made, being diluted in water, and there suspended by the Arabic or Senegal gums.

10. One hundred parts of this salt, recently crystallised, contain 20 of real vitriolic acid, 25 of iron, and 55 of water.

11. Its acid is known by this, that its solution mixes without turbidity with the solutions of other salts that contain vitriolic acid; as Epsom, selenite, vitriolated tartar, &c.

12. And the basis of this metallic salt is known by the black colour produced by the solution of vegetable astringents.

13. On being urged by the flame thrown by the blow-pipe, it offers the same phenomena as the vitriol of copper, except that it does not colour the flame.

Green vitriol is frequently found native, either in coal mines or in the cavities of pyritaceous mines, or adhering to their scaffolds in a stalactitical form. It is found also in small round stones, called *ink-stones*, of a white, red, grey, yellow, or black colour, which are almost soluble in water, and contain a portion of copper and zinc. Also sometimes in form of schistus or stony pyritaceous stones. But the greatest part of that in use is prepared by art, from the martial pyrites or mundic. See *CHEMISTRY*, n° 619.

IV. Aerated iron. *Ferrum aeratum.*

This metallic salt is a combination of the aerial acid with iron; and is found in the light chalybeate waters, where it is dissolved by an excess of this acid.

Mr Lane was the first who discovered in England the action of the aerial acid on iron, when the water is impregnated with that menstruum. The late M. Rouelle demonstrated the same phenomenon in France upon this and other metals. But Professor Bergman seems to have preceded them both nearly about the same time, though neither had any knowledge of each other's discoveries.

The great volatility of this acid is the cause why this neutral salt is not often found. For the mere evaporation of the ferruginous mineral waters, in order to analyse them, is sufficient to let loose the aerial acid; so that the iron which was there dissolved by its power falls down to the bottom in the form of a light ore, which amounts to nearly $\frac{1}{10500}$ of the weight of the water; and when

*Metallic
Neutral
SALTS.*

V. Vitriol of cobalt, or vitriolated cobalt.

This metallic salt results from the combination of the vitriolic acid with cobalt.

1. When found native, it is always in an efflorescent state; whence it arises that, in this case,
2. Its colour is greenish, mixed with a grey tint; but,
3. It is of a rosy colour when artificially made;
4. Effloresces when exposed to the action of the atmosphere; and,
5. Takes then a greenish colour mixed with a pale purple, or a *Lilias colour*, as the French call it.
6. It is difficultly soluble in water; and,
7. Its solution is of a red colour.

8. The phlogisticated alkali precipitates the cobalt from the solution of this salt, which with borax gives an azure glass.

By the above qualities, chiefly the rosy colour of the solution of this neutral salt, its basis is sufficiently distinguished. As to its acid, it is easily known by the same tests as those of the preceding vitriols.

It is said to be found native in small pieces, mixed with a greenish efflorescence in cobalt mines. (*Kirwan and Mongez.*)

VI. Vitriol of zinc, vitriolated zinc, or white vitriol.

This neutral metallic salt results from the combination of vitriolic acid with zinc.

1. Its colour is white. It,
2. Requires little more than twice its weight of water to dissolve it in the temperature of 60 degrees of Fahrenheit's thermometer, and deposits a greyish yellow powder.
3. Its specific gravity is 2000.
4. Its taste is very styptic.
5. It mixes uniformly with vitriolic neutral salts.
6. Precipitates nitrous or marine selenites from their solutions, by which its acid is ascertained.
7. It is precipitable in a whitish powder by alkalies and earths; but,
8. Neither iron, copper, nor zinc, precipitate it: by which circumstance its basis is sufficiently indicated.
9. If it contains any other metallic principle, this may be precipitated by adding more zinc to the solution; excepting iron, which will of itself precipitate by exposure to the air or boiling in an open vessel.
10. One hundred parts of this metallic salt contain 22 of vitriolic acid, 20 of zinc, and 58 of water.
11. Urged by fire, it loses a good part of its acid.
12. Treated with the blow-pipe, it exhibits nearly the same phenomena as other metallic vitriols; except only that the flame is brilliant when the zinc is reduced, and gives out white flocs called *flowers of zinc*.

This neutral metallic salt is sometimes found native, mixed with vitriol of iron, and in the form of white hairy crystals; or in a stalac-

titical form in the mines of Hungary, or as an efflorescence on ores of zinc. It is also found dissolved in mineral waters, and generally with some proportion of vitriols of iron and copper. Bergman says, it is sometimes produced by the decomposition of pseudogallena, or black-jack; but this rarely happens, because this substance does not readily decompose spontaneously.

But that in common use is mostly prepared at Goslar, from an ore which contains zinc, copper, and lead, mineralized by sulphur and a little iron. The copper is first separated as much as possible: the remainder after torrefaction and distillation is thrown red-hot into water and lixiviated. It is never free from iron. (*Kirwan, Mongez.*)

VII. Vitriolated nickel, or vitriol of nickel

This neutral metallic salt results from the combination of the vitriolic acid with nickel. It exists sometimes in consequence of the decomposition of the sulphureous ores of this semimetal. It is found native, efflorescing on Kupfer-nickel; and generally mixed with vitriol of iron.—It is of a green colour, as well as its solution. It is precipitated by zinc; but when joined with iron, this last is not precipitated by the same.

Its origin is perhaps owing to the decomposition of the pyritaceous and sulphureous ore of Kupfer-nickel, mentioned by Wallerius. This ore contains a great quantity of arsenic and sulphur, as well as cobalt, nickel, and iron. And if it comes to be decomposed in the bowels of the earth, it is natural to expect that the vitriolic acid of the sulphur will attack the nickel and the iron, with which it will form neutral metallic salts (*Mongez, Kirwan*).

VIII. Muriatic manganese. *Manganesium salitum.*

M. Hielm is the only person who has as yet found this middle salt in some mineral waters of Sweden. It is composed by the combination of the regulus of Manganese with muriatic acid.

1. It is precipitated of a whitish yellow colour, by the Prussian (phlogisticated) alkali; and of a brownish yellow, by the mineral alkali.
2. It does not crystallize in any distinct form.
3. It abstracts the moisture of the air.
4. To obtain its basis free from iron, it must be precipitated by the mineral alkali; redissolved in nitrous acid; then calcined until this acid is expelled; and the residuum is to be treated with distilled vinegar, which will then take up only the manganese. (*Kirwan.*)

Order VI. TRIPLE SALTS.

THE neutral salts hitherto enumerated are such as are composed of two ingredients only; but sometimes three or more are so united as not to be separated by crystallization. The vitriols that we are acquainted with are hardly ever pure; and two or three of them sometimes are joined together.

Sometimes likewise it happens that neutral salts join earthy salts, and earthy salts metallic ones. Bergman generally distinguishes compound salts according to

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Neutral
SALTS.*

Triple
Neutral
SALTS.

the number of their principles, whether the same acid be joined to several bases, or the same base to different acids; or, lastly, whether several menstrua and several bases are joined together. Hence arise salts triple, quadruple, &c. which the diligence of after-times must illustrate. The most remarkable examples of triple and quadruple native salts which have yet occurred are,

I. Mineral alkali, with a small quantity of calcareous earth. *Alkali salis communis*. Aphronitrum.

This is so strongly united with the calcareous earth, that the latter enters with it into the very crystals of the salt: though by repeated solutions the earth is by degrees separated from it, and falls to the bottom after every solution.

It grows in form of white frost on walls, and under vaults; and in places where it cannot be washed away by the rain.

Hence it would appear, that this is not only a triple, but a multiple salt; as these pieces of old mortar covered with this white frost, on ancient walls, are the very same from which the saltpetre makers extract the mother-water of nitre, after mixing therewith the vegetable ashes, to furnish the alkaline base to it. M. Fourcroy says in his seventeenth Lecture, that this mother-water contains not only nitre, but five other kinds of salt, viz. the marine salt, nitrous magnesia, calcareous nitre, magnesia nitrata, and calc. sekta; to which the chemists of Dijon add the digestive salt of Sylvius, and in some cases various vitriols with alkaline or earthy bases.

When it contains any considerable quantity of the calcareous earth, its crystals become rhomboidal, a figure which the calcareous earth often assumes in shooting into crystals: but when it is purer, the crystals shoot into a prismatic figure.

This is a circumstance which necessarily must confuse those who know the salts only by their figure; and shows, at the same time, how little certainty such external marks afford in a true distinction of things.

This salt is very often confounded with the *sal mirabile Glauberi*.

II. Common salt with magnesia; or muriatic mineral alkali contaminated by muriatic magnesia.

This is a compound of the common salt with muriatic magnesia: and by the expression contaminated (*inquinatum*) of professor Bergman, we may suppose that the magnesian salt is not intimately united to the alkaline base.

This triple salt is very deliquescent; a quality it owes to its integrant part the muriatic magnesia, (p. 97. col. 1.) For the pure muriatic alkali does not deliquesce: but this degree of purity is seldom found, even in the native fossil or *sal gem*, (p. 93. col. 2.) In general all the earthy marine salts are very deliquescent, as the muriatic chalk, the muriatic barytes, and the muriatic magnesia. *Bergman, Macquer, and Mongez.*

III. Mineral alkali with succinous acid and phlogiston. This substance will be afterwards mentioned among the inflammables.

IV. Vitriolated magnesia with vitriol of iron. Epsom salt contaminated with copperas.

Found in some mineral waters, according to Mr Monnet, (*Treatise on Mineral Waters*).

V. Native-alum contaminated by copperas. Vitriolated argil with vitriol of iron.

Found in the aluminous schistus. It sometimes effloresces in a feathery form. Perhaps this is the *plumose alum* of the ancients.

VI. Native alum, contaminated by sulphur.

At the places about Wednesbury and Bilston, in Staffordshire, where the coal pits are on fire, this substance sublimes to the surface; and may be collected, in considerable quantity, during dry or frosty weather.

A similar compound substance sublimes at the Solfaterra near Naples.

VII. Native alum contaminated by vitriolated cobalt. In the mines of Herregrund and Idria this salt may be seen shooting out into long slender filaments. Perhaps this is the *trichites* of the Greeks.

1. Dissolved in water, it immediately betrays the presence of vitriolic acid upon the addition of terra poderosa salita (muriatic acid saturated with heavy earth).

2. By the addition of phlogisticated alkali, a precipitate of cobalt is thrown down, which makes blue glass with borax or microcosmic salt. (*Berg. Sciag.*)

VIII. Vitriol of copper with iron.

This salt is of a bluish green colour. It is the *vitriolum ferreo-cupreum cyaneum* of Linnæus. Its colour varies, being sometimes more or less green, and sometimes more or less blue. It is found at Saltzberg and at Falhun. This vitriol is called *vitriol of Hungary*, because it is found in the Hungarian mines is of this kind. (*Mongez.*)

IX. Vitriol of copper, iron, and zinc.

This is the *vitriolum ferreo-zinco cupreum cyaneum* of Linnæus. Its colour is of a blue inclining to green. If rubbed on a polished surface of iron, the copper is not precipitated thereby, as it happens to the blue vitriol; which shows that the vitriolic acid is perfectly saturated in this salt by the three metallic bases.

X. Vitriol of copper and zinc.

This is the blue vitriol from Goslar. According to Mongez it is the *vitriolum zinco-cupreum ceruleum* of Linnæus.

XI. Vitriol of iron and zinc.

This is the green vitriol from Goslar in the Hartz. According to Mongez, this is the *vitriolum zinco-ferreum viride* of Linnæus, 105. 6. Its colour is a pale-green cast.

XII. Vitriol of iron and nickel.

This salt is of a deep-green colour, and is contained in the ochre, or decayed parts, of the nickel, at the cobalt-mines of Los, in the province of Helsingland.

CLASS III. MINERAL INFLAMMABLE SUBSTANCES.

To this class belong all those subterraneous bodies that are dissoluble in oils, but not in water, which they

Triple
Neutral
SALTS.

Inflam-
mables.

repel; that catch flame in the fire; and that are electrical.

It is difficult to determine what constitutes the difference between the purer sorts of this class, since they all must be tried by fire, in which they all yield the same product; but those which in the fire show their differences by containing different substances, are here considered as being mixed with heterogeneous bodies: that small quantity of earthy substance, which all phlogistons leave behind in the fire, is, however, not attended to.

I. Inflammable air; fire damp.

This aeriform substance is easily known by its property of inflaming when mixed with twice or thrice its bulk of common atmospheric air; and it is asserted to be the real phlogiston almost pure. See *AEROLOGY-Index*, and *INFLAMMABLE Air*.

It admits considerable varieties, according to the nature of the substances from which it is produced, and often gives different residuums upon combustion, some of which are of the acid kind. If it is produced from charcoal, it yields aerial acid or fixed air: from solutions of metallic substances in the vitriolic, nitrous, or marine acids, it yields these respective acids, as M. Lavoisier asserts.

Æther, converted into vapour in a vacuum, gives a permanent elastic vapour, which is inflammable. The atmosphere, which floats round the fraxinella, is inflammable from the admixture of its vapours, which seem to be of the nature of an essential oil: so that on approaching the flame of a candle under this plant, in hot weather, it takes fire in an instant; although the essential oil, extracted from this plant by distillation, is not inflammable on account of the watery particles mixed with it, as M. Bomare asserts.

Mr Scheele is of opinion, that every inflammable air is composed of a very subtle oil. This coincides with the idea entertained by chemists of their phlogiston; and is confirmed by the fact, of its being naturally found in those springs from whence issues petrol, whose exhalations are very inflammable.

The residuum, which remains in the atmosphere after the combustion of inflammable air, is extremely noxious to animals. Doctor Priestley takes it to be a combination of phlogiston with pure air, and on this account calls it *phlogisticated air*. But M. Lavoisier, on the contrary, considers it to be a primitive substance of an unchangeable nature, and gives it the singular name of *atmosphæric mephitis*.

II. Hepatic air.

This air seems to consist of sulphur, held in solution in vitriolic or marine air. It is inflammable when mixed with three quarters of its bulk of common air. Nitre will take up about half the bulk of this air; and when saturated

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mables.

with it, will turn silver black: but if strong dephlogisticated nitrous acid be dropped into this water, the sulphur will be precipitated.

One hundred cubic inches of this air may hold eight grains of sulphur in solution in the temperature of 60°; and more, if hotter.

Atmospheric air also decomposes hepatic air.

It is found in many mineral waters, and particularly in the hot baths of Aix-la-Chapelle. The cause and manner of their containing sulphur, which was long a problem, has at last been happily explained by Mr Bergman.

It plentifully occurs in the neighbourhood of volcanoes and in several mines.

Hepatic air is easily obtained by art, from all sorts of liver of sulphur, whether the base be an alkali, an earth, or a metal, if any acid is poured upon it; and the better, if use be made of the marine acid, because it contains phlogiston enough, and does not so strongly attract that of the *hepar sulphuris*. For this reason the nitrous acid is not fit for this process, as it combines itself with the phlogiston, and produces nitrous air. It may also be produced, by distilling a mixture of sulphur and powdered charcoal, or of sulphur and oil, &c. See the detached article *HEPATIC Air*, and *AEROLOGY-Index*.

III. Phlogiston combined with aerial acid; black lead, or wadd. *Plumbago*. See the detached article *Black-LEAD*.

It is found,

a. Of a steel-grained and dull texture. It is naturally black, but when rubbed it gives a dark lead colour.

b. Of a fine scaly and coarse-grained texture; coarse black-lead.

IV. Mineral tallow. *Serum minerale*.

This was found in the sea on the coasts of Finland in the year 1736. Its specific gravity is 0.770; whereas that of tallow is 0.969. It burns with a blue flame, and a smell of grease, leaving a black viscid matter, which is with more difficulty consumed.

It is soluble in spirit of wine only when tartarised: and even then leaves an insoluble residuum; but expressed oils dissolve it when boiling.

It is also found in some rocky parts of Persia, but seems mixed with petrol, and is there called *schebenraad, isfenpen, kodretti*.

Dr Herman of Strasburg mentions a spring in the neighbourhood of that city, which contains a substance of this sort diffused through it, which separates on ebullition, and may then be collected. (*Kirwan*).

V. Ambergris. *Ambra grisea*.

It is commonly supposed to belong to the mineral kingdom, although it is said to have doubtful marks of its origin (a).

a. It

(a) Ambergris, according to the assertion of M. Aublet (in his *Histoire de la Guiane*), is nothing more than the juice of a tree inspissated by evaporation into a concrete form. This tree grows in Guyana, and is called

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mables.

- a. It has an agreeable smell, chiefly when burnt :
 b. Is consumed in an open fire :
 c. Softens in a slight degree of warmth, so as to stick to the teeth like pitch.
 d. It is of a black or grey colour ; and of a dull or fine grained texture (B).

The grey is reckoned the best, and is sold very dear. This drug is brought to Europe from the Indies. It is employed in medicine ; and also as a perfume (c).

VI. Amber. *Ambra flava, succinum, electrum*, Lat. *Carabé*, French. *Agstein, Bernstein*, Germ.

This substance is dug out of the earth, and found on the sea-coasts. According to the experiments of M. Bourdelin, it consists of an inflammable substance, united with the acid of common salt, which seems to have given it its hardness.

It is supposed to be of vegetable origin, since it is said to be found together with wood in the earth.

By distillation it yields water, oil, and a volatile acid salt, which the above mentioned author has thought to be the acid of common salt united with a small portion of phlogiston.

Insects, fish, and vegetables, are often found included in it, which testify its having once been liquid.

It is more transparent than most of the other bitumens ; and is doubtless the substance which first gave rise to electrical experiments (on account of the power it possesses of attracting little bits of straw, or of other light substances, when rubbed).

Its varieties are reckoned from its colour and transparency. It is found,

A.

called *cuma*, but has not been investigated by other botanists. When some branches are broken by high winds, a large quantity of the juice comes out ; and if it chances to have time to dry, various masses (some of which had been so large as to weigh 1200 pounds and more) are carried into the rivers by heavy rains, and through them into the sea : afterwards they are either thrown into the shore or eaten by some fish, chiefly the spermaceti whale, known by the name of *Physeter-macrocephalus* among ichthyologists. This kind of whale is very greedy of this gum-resin, and swallows such large quantities when they meet with it, that they generally become sick ; so that those employed in the fishery of these whales, always expect to find some amber mixed with the excrements and remains of other food in the bowels of those whales who are lean. Various authors, among whom is Father Santos in his *Ethiopia Orientalis*, who travelled to various places of the African coast, and Bomare, say, that some species of birds are fond of eating this substance as well as the whales and other fishes. This accounts very well for the claws, beaks, bones, and feathers of birds, parts of vegetables, shells, and bones of fish, and particularly for the beaks of the cuttle fish or *sepia octopodia*, that are sometimes found in the mass of this substance. Dr Swedjar, however, attended only to these last, though he had mentioned also the other substances in his paper inserted in the Philosophical Transactions for 1783 ; wherein he attempts to establish an opinion, that the amber is nothing else but a preternaturally hardened dung, or feces, of the physeter whale. Dr Withering and Mr Kirwan have embraced this notion ; as did also, inadvertently, the editors of this Work. See AMBERGRIS.

(B) Mr Aublet brought specimens of this gum-resin, which he collected on the spot, from the *cuma* tree at Guiane. It is of a whitish-brown colour with a yellowish shade, and melts and burns like wax on the fire. The singularity of this gum-resin is, that it imbibes very strongly the smell of the aromatic substances which surround it ; and it is well known that perfumers avail themselves very considerably of this advantage. M. Rouelle examined very carefully this substance brought over by Mr Aublet, and found that it produced the very same results as in other good kind of amber. Besides Mr Aublet's authority, which is decisive, as being grounded upon direct proofs of fact, Rumphius, quoted by Bergman, long since mentioned a tree called *Nanarium*, whose inspissated juice resembles amber. It cannot therefore at present be doubted that the origin of this phlogistic substance is the vegetable kingdom, although it may be often found and reputed as a product of the fossil kind.

This substance being analysed by Messrs Geoffroy and Newman, quoted by M. Fourcroy, yielded them the same principles as the bitumens ; viz. an acid spirit, a concrete acid salt, some oil, and a charry residuum ; which evidently evinces, that all these fat and oily fossil substances have their origin from the other two kingdoms of nature.

(C) Ambergris is not only brought from the East Indies, but from the coasts of the Bahama Islands, Brasil, Madagascar, Africa, China, Japan, the Molucca islands, the coasts of Coromandel, Sumatra, &c. Dr Lippert, in a treatise he published at Vienna in 1782, entitled *Phlogistologia Mineralis*, has copied chiefly from Wallerius what he asserts of this substance. He affirms that there are eight known species of amber ; five of a single colour, viz. the white and the black from the island of Nicobar, in the gulph of Bengal, the ash-coloured, the yellow, and the blackish ; and two variegated, viz. the grey coloured with black specks, and the grey with yellow specks. This last he asserts to be the most esteemed on account of its very fragrant smell, and to come from the South coast of Africa and Madagascar, as well as from Sumatra ; and that the black dark coloured amber is often found in the bowels of the cetaceous fishes. The same author adds also from Wallerius, that by distilling the oil of yellow amber (*succinum*) with three parts and a half of fuming nitrous acid, a residuum remains like rosin, which emits a perfect smell of musk ; whence some conclude, that the ambergris belongs to the fossil kind : the contrary, however, is evinced in the preceding note.

Inflam-
mables.Inflam-
mables.

A. Opaque.

- a. Brown.
- b. White.
- c. Blackish.

B. Transparent.

- a. Colourless.
- b. Yellow.

The greatest quantity of European amber is found in Prussia; but it is, besides, collected on the sea-coast of the province of Skone, and at Biorko; in the lake Malaren in the province of Upland; as also in France and in Siberia. It is chiefly employed in medicine and for making varnishes (D).

VII. Rock-oil.

This is an inflammable mineral substance, or a thin bitumen, of a light brown colour, which cannot be decomposed; but is often rendered impure by heterogeneous admixtures. By length of time it hardens in the open air, and then resembles a vegetable resin; in this state it is of a black colour, whether pure or mixed with other bodies. It is found,

A. Liquid.

1. Naphtha.

This is of a very fragrant smell, transparent, extremely inflammable, and attracts gold. It is collected on the surface of the water in some wells in Persia. See НАФТА.

2. Petrol.

This smells like the oil of amber, though

more agreeable; and likewise very readily takes fire. It is collected in the same manner as the Naphtha from some wells in Italy. See PETROLEUM.

B. Thick and pitchy; *Petroleum tenax*. Barba-
does-tar.

This resembles soft pitch.

It is found at the Dead Sea in the Holy Land; in Persia, in the chinks of rocks, and in strata of gypsum and limestone, or floating on water; also in Siberia, Germany, and Switzerland, in coal-pits; and in America: likewise in Colebrookdale in England.

C. Elastic petrol.

This is a very singular fossil, found of late in England.

By its colour and consistency, it exactly resembles the Indian-rubber, or the gum-resin, from the north part of Brasil, called *caoutchouc*. It is of a dark brown colour, almost black; and some is found of a yellowish brown cast, like the same gum-resin.

With respect to its elastic consistence, it hardly can be distinguished from it, except in the cohesion of its particles, which is weaker.

It has the same property of rubbing off from paper the traces of black-lead pencils.

It burns likewise with a smoky flame; and also melts into a thick oily fluid; but emits a disagreeable smell, like the fossil pitch, or Barbadoes tar.

It

(D) Amber, says M. Fourcroy, is found in small detached pieces, for the most part under coloured sands, dispersed in beds of pyritaceous earth; and above it is found wood, charged with a blackish bituminous matter. Hence it is strongly supposed that it is a resinous substance, which has been altered by the vitriolic acid of the pyrites, notwithstanding that we know that acids, when concentrated, always blacken and charry resinous substances. In fact, the chemical analysis of this substance rather confirms that supposition.

The singular opinion of Dr Girtanner, about the yellow amber being produced by a kind of ants, may be seen in *Journal de Physique* for March 1786, page 227. Or see the article AMBER in this Dictionary.

The colour, texture, transparency, and opacity of this substance, have shown some other varieties besides these mentioned in the text. The principal ones are the following:

- | | | | |
|--|-----------|------------------------|----------------|
| 6. The yellow succinum, | } opaque. | 9. The white, | } transparent. |
| 7. The coloured green or blue by foreign matter, | | 10. The pale-yellow, | |
| 8. The veined succinum, | | 11. The citron-yellow, | |
| | | 12. The deep-red, | |

The golden yellow transparent amber, mentioned in the text, is what the ancients called *chrysoléctrum*, and the white opaque was called *leucoléctrum*.

But we must be cautious about the value of the specimens remarkable for their colour, size, transparency, and the well-preserved insects they contain internally; since there is a probability of deception, several persons possessing the art of rendering it transparent and coloured, and of softening it, so as to introduce foreign substances, &c. into it at pleasure.

M. Fourcroy says, that two pieces of this substance may be united, by applying them to one another, after being wet with oil of tartar and heated. And Wallerius mentions, that pieces of yellow amber may be softened, formed into one, and even dissolved by means of oil of turnip-seed, in a gentle heat; and that according to some authors, it may be rendered pure and transparent, by boiling it in rape-seed oil, linseed oil, salt-water, &c.

Mr Macquer says, that for the purpose of making varnish, this substance must undergo beforehand a previous decomposition by torrefaction, in order to be dissolved by linseed-oil or essential oils. See VARNISH.

Besides the making of varnishes, this substance was much employed formerly in making various pieces of ornament and jewellery. The best pieces were cut, turned, carved, or plained, to make vases, heads of canes, collars, bracelets, snuff-boxes, beads, and other toys, small fine chelts, &c. But after diamonds and beautiful hard stones were brought into use, these trinkets are little considered in Europe: nevertheless, they are still sent to Persia, China, and to various other eastern nations, who esteem them still as great curiosities.

It is found in the same earthy and stony beds as petrol. Some specimens are of a cylindrical form, like bits of thin branches or stalks of vegetables, though much more flexible, being perfectly elastic.

M. Magellan observes, that this fossil seems to favour the opinion of those mineralogists, "who believe that these oily combustibles derive their origin from the vegetable kingdom. It seems worth trying, whether pieces of asphaltum, buried in damp beds of sparry rubbish, or other kind of earths, would take the same elastic consistence. But since many beds of shells and other fossil substances, both of the vegetable and animal kind, as impressions of various plants, and the remains of various quadrupeds, &c. have been found in different parts of the globe, whose individual species undoubtedly exist no longer alive unless in far distant climates, and in the most remote countries from the spot where their exuvia are dug out; why should we not allow that this new fossil may be the same original elastic gum, now growing naturally in Brasil, China, and other hot climates, only altered in its smell, and in the tenacity of its particles, by its long deposition during centuries in the bowels of the earth?"

This elastic petrol was found in 1785, near Casseltown, in the county of Derbyshire in England, but in very inconsiderable quantities.

D. Hardened rock-oil; fossil pitch. *Petroleum induratum, Pix montana.*

1. Pure asphaltum.

This leaves no ashes or earthy substance when it is burnt.

It is a smooth, hard, brittle, inodorous, black or brown substance. When looked through in small pieces, appears of a deep red colour. It swims in water.

It breaks with a smooth shining surface.—Melts easily: and, when pure, burns without leaving any ashes; but if impure, leaves ashes or a slag.

According to M. Monet, it contains sulphur, or at least the vitriolic acid.

It is slightly and partially acted on by alcohol and æther.

From this, or the preceding substance, it is probable the asphaltum was prepared that the Egyptians used in embalming their dead bodies, and which is now called *mumia*.

It is found also on the shores of the Red Sea, in the Dead Sea, in Germany, and France.—(*Kirwan.*)

And it comes likewise from Porto Principe, in the island of Cuba. (*Brun.*)

It is found also in many parts of China; and is employed as a covering to ships by the Arabs and Indians. (*Fourcroy.*)

2. Impure; *Pix montana impura*. Pissaphaltum.

This contains a great quantity of earthy matter, which is left in the retort after distillation, or upon the piece of charcoal, if burnt in an open fire; it coheres like a slag, and is of the colour of black-lead: but in a calcining heat, this earth quickly volatilises, so that the nature of it is not yet known.

N^o 223.

It is found in Mossgrufvan in Norberg, and in Grognerberget, both in the province of Westmanland; and also in other places.

The pissaphaltum is of a mean consistence between the asphaltum and the common petroleum. It is the very bitumen which is collected in Auvergne in France in the well called *de la Pege*, near Clermont Ferrand.

VIII. Jet. *Gagas, Succinum nigrum.*

This is a very compact bitumen, harder than asphaltum, always black, and susceptible of a good polish. It becomes electrical when rubbed; attracts light bodies like the yellow amber; and it swims on water.

It seems to be nothing else than a black amber, or succinum; but specifically lighter, on account of the greater portion of bitumen that enters into its composition. When burned, it emits a bituminous smell. See the article JET.

IX. Mineral phlogiston united with earths.

A. With calcareous earth.

1. With pure calcareous earth. This is the fetid or swine spar formerly described.

B. United with calcareous, argillaceous, ponderous, and siliceous earth and vitriolic acid. Liverstone: *Lapis hepaticus.*

C. With an argillaceous earth; Pit or Stone Coal.

1. With a small quantity of argillaceous earth and vitriolic acid. *Lithanthrax.* See the articles COAL and PIT-COAL.

This is of a black colour, and of a shining texture: it burns with a flame, and is mostly consumed in the fire; but leaves, however, a small quantity of ashes.

a. Solid coal. b. Slaty coal.

2. Culm-coal, called *kolm* by the Swedes.

This has a greater quantity of argillaceous earth and vitriolic acid, and a moderate proportion of petrol.

It has the same appearance with the preceding one, though of a more dull texture: it burns with a flame; and yet is not consumed, but leaves behind a slag of the same bulk or volume as the coal was.

From England, and among the alum rock at Moltorp and Billingen in the province of Westergottland.

3. Slate-coal.

This coal contains abundance of argillaceous earth. It burns with a flame by itself, otherwise it looks like other slates.

It is found at Gullerafen in the parish of Rettwik, in the province of Dalarne, and also with the coals at Boserup in Skone.

This seems to be the same with the bituminous schistus, already described among the argillaceous earths.

4. Cannel-coal.

Mr Kirwan has put together this variety of coal with that other called *Killkenny-coal*, tho' they have some different properties.

The cannel-coal is of a dull black colour; breaks easily in any direction; and, in its fracture, presents a smooth conchoidal surface, if broken transversely.

It contains a considerable quantity of petrol, in

in a less denser state than other coals; and burns with a bright lively flame, but is very apt to fly in pieces in the fire. It is said, however, to be entirely deprived of this property, by being previously immersed in water for some hours.

Its specific gravity is about 1270; and being of an uniform hard texture may be easily turned in the lathe, and receive a good polish.

It is from this kind of coal that small vases, as ink-stands, various trinkets, and other curiosities, are made in England, which appear as if made of the finest jet.

6. Kilkenny-coal.

This contains the largest proportion of petrol or asphaltum; burns with less flame and smoke, and more slowly, though intensely, than the cannel-coal.

The quantity of earth in this coal does not exceed one twentieth of its weight. Its specific gravity is about 1400. It is frequently mixed with pyrites.

It is found in the county of Kilkenny, belonging to the province of Leinster in Ireland. The quality of this coal burning almost without smoke, is mentioned in a proverb by which the good qualities of this county are expressed.

6. Sulphureous coal.

This consists of the former kinds of coal, mixed with a notable proportion of pyrites: hence it is apt to moulder and break when exposed to the air. It contains yellow spots that look like metal; and burns with a sulphureous smell, leaving either red ashes, or a slag, or both. Water acts upon it, after it has mouldered. Its specific gravity is = 1500, or more.

Besides the above varieties, schistus, micaceous schistus, and gneiss, are frequently found in the neighbourhood of coal-mines, so penetrated with petrol bitumen as to constitute an inferior species of coal; but the bitumen being burnt, they preserve their form, and in some measure their hardness. Also some grey slates, that are so soft as to be scraped with the nail, and are greasy to the touch, burn like coal.

All the differences of coal arise from a mixture of the varieties already mentioned; and it is observable, that wherever coals exist, slates are generally found near them. Salt or mineral springs are also often found in their neighbourhood. (Kirwan.)

7. Bovey coal. *Xylanthrax*.

This is of a brown, or brownish black colour, and of a yellow laminar texture.

The laminæ are frequently flexible when first dug, though generally they harden when exposed to the air.

It consists of wood penetrated with petrol or bitumen; and frequently contains pyrites, alum, and vitriol.

Its ashes afford a small quantity of fixed al-

kali, according to the German chemists; but according to Mr Mills they contain none.

By distillation it yields an ill smelling liquor, mixed with a volatile alkali and oil, part of which is soluble in spirit of wine, and part infusible, being of a mineral nature.

It is found in England, France, Italy, Switzerland, Germany, Ireland, &c. (Kirwan.)

8. Peat. *Geanthrax*.

There are two sorts of inflammable substances known by this name, viz.

The first of a brown, yellowish brown, or black colour, found in moorish grounds; in Scotland, Holland, and Germany. When fresh, it is of a viscid consistence, but hardens by exposure to the air. It consists of clay mixed with calcareous earth and pyrites; and sometimes contains common salt. While soft, it is formed into oblong pieces for fuel, after the pyritaceous and stony matters are separated. When distilled, it affords water, acid, oil, and volatile alkali. Its ashes contain a small proportion of fixed alkali. They are either white or red, according as it contains more or less ochre or pyrites.

The second is found near Newbury in Berkshire. It contains but little earth; but consists chiefly of wood, branches, twigs, roots of trees, with leaves, grals, straw, and weeds. (Kirwan.)

9. Stone-turf.

Cronstedt has ranged the turf among the fossils of his Appendix; but as that called in England by the name of *stone-turf* contains a considerable proportion of peat, it may be mentioned with propriety in this class.

Soon after it is dug out from the ground, where it keeps a soft consistence, it at first hardens; but afterwards it crumbles by long exposure to the air.

As to the other common turf, it only consists of mould interwoven with the roots of vegetables; but when these roots are of the bulbous kind, or in a large proportion, they form the worst kind of turf.

Although it may appear incredible, it is nevertheless a real fact, that in England pit-turf is advantageously employed in Lancashire to smelt the iron-ore of that county. Mr Wilkinson, brother-in-law to Dr Priestley, and famous for his undertakings in the extensive iron-works, perhaps the greatest in Europe, makes use of pit-turf in his large smelting furnaces of that province.

THOSE fossil substances, which furnish fuel for the various purposes of human life, are distinguished by the name of *coals*, on account of their being a succedaneum for wood and other vegetable productions, which when dry or of an oleaginous kind serve for the same uses. If these vegetable substances are deprived of the access of air, by covering them after ignition, the half-consumed remainder, which is of a black colour, is called by the name of *coal* or *charcoal*; and from hence the fossil which affords fuel has

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mables.

also been called by the same name, though of a very different nature.

Pit-coal and earth-coal are synonymous, and mean coals dug out of a pit or from the earth. But the lithanthrax denotes stone-coal, and more properly indicates the cannel-coal, which has the greatest similarity to a stony substance, by the dull appearance of its fracture and by the uniform texture of its parts.

All these coals are in general a bituminous black or brown and dark substance: for the most part they have a lamellated texture, which breaks easily, and always with a shining surface.

The varieties of pit-coals above-mentioned are the most remarkable, by which they may be distinguished from one another. But they are far from being homogeneous in each kind; as the accidental qualities, and the various proportions of their component parts, produce a far greater number of properties, which renders them more or less fit for different purposes; though these are generally overlooked, and confounded with the common one of affording fuel for making fire to warm our rooms, or for culinary operations.

This fossile bitumen, as Fourcroy remarks, being

heated in contact with a body in combustion, and a free access of air, kindles the more slowly, and with more difficulty, as it is more weighty and compact. When once kindled, it emits a brisk and very durable heat, and burns for a long time before it is consumed. If extinguished at a proper time, the remaining cinders may serve several times for a new firing with a small addition of fresh coals. The matter that is burned, and produces the flame, appears very dense, as if united to another substance which retards its destruction. Upon burning, it emits a particular strong smell, which is not at all sulphureous when the earth-coal is pure, and contains no pyrites.

When the combustible, oily, and most volatile parts, contained in the earth-coal, are dissipated and set on fire by the first application of heat; if the combustion is stopped, the bitumen retains only the most fixed and least inflammable part of its oil, and is reduced to a true charry state, in combination with the earthy and fixed base. Pit-coals in this charry state are called *coaks*, which are capable of exciting the most intense heat; and are employed all over Britain in the smelting of iron, copper, and other metallic ores, to the greatest advantage. See COAKS, COAL, COALERY, and PIT-COAL (E).

Inflam-
mables.

X. The

† *Nat. Hist.*
of the Mi-
neral King-
dom.

(E) The coal-metals, or stone strata inclosing coals, are very numerous. Mr Williams † gives the following general account of those in Scotland.

The sand-stones. Of these there is a great variety, distinguishable by colour, texture, and degrees of hardness, generally disposed into thick, middling, and thin strata. The only species our author takes notice of is the regular broad-bedded free-stone of a laminated texture. This commonly rises in thin or middling strata; appearing at the edges of a section, when broken or cut, to be formed of thin lamina or layers of sand, equally laid on the whole breadth of the stone, and well cemented together. A great deal of both red and white free-stone rise in layers of five or six inches, and so upwards, with regular streaks of a fifth or sixth part of an inch appearing the whole length of the stone, when the edge of a slab is polished, as if so many gentle waves of water had formed the layer. The regularity of the structure of this stone corresponds exactly with the regularity of its layers; and our author is of opinion, that the slaggy grey-strata of free stone, with many of the black and grey-strata of coal metals, the grey slate, as well as many other thin strata of the coal metals, may be ranked with this free stone for perfect and regular stratification.

Along with these he classes some of the thin argillaceous strata. "Many of the grey regularly stratified mountain limestones (says he) are also streaked or striped; and the streaks in these appear more conspicuous when broken than the streaked free stones. Some of the hard regularly stratified mountain rocks are also stratified; and in all these three kinds of stones, the streaks are regularly and exactly parallel to the bed of the stone."

Another remarkable instance of regularity of strata is met with in the grey slaggy strata of Caithness.—Throughout all the low country of Caithness, a square of about 10 or 15 miles, there are bluish argillaceous strata, with generally a small quantity of lime in the composition of the stone, which is indurated to a greater degree than is common to such thin strata. The stone is strong and tough, every where disposed in thin broad-bedded, regular strata; and in several parts of the country the flags are so thin and regular, and are raised so light and broad, that they are used for covering houses; and three or four of them will cover the side of a small one. Our author mentions a gentleman who has an estate on the south side of the Pentland frith, and who in a bay there raises flags of any size and thickness he pleases; "so truly flat and smooth, that he has only to square the edges to make of them good loft-floors, partitions, chests, mangers, roofs of houses; in short, he does every thing with them. The face of these flags are as smooth and true a plane, as if artificially finished by the best workman."

In most coal fields there are a great variety of strata of different kinds accompanying and lying between the seams of coal, of all sorts of colours, consistencies, and dimensions; all of them blended together without any certain order or regularity; so that if there be 20 seams of coal, it is possible that there may be as many different roofs; that is, the stratum which is the immediate roof of one seam of coal, shall differ from that of another seam in quality, thickness, and colour, so that perhaps no two of the twenty shall be in any respect alike.

The various kinds of coal-roofs (a) commonly met with are the following.

1. Ba-

(a) The stratum which is placed immediately above a seam of coal, is called the *roof* of the coal, and that which is placed immediately below the seam, is called the *pavement* of the coal: which three, viz. the stratum of coal, and its roof and pavement, with the other concomitant strata lying above and below them, always preserve their positions and parallelism; that is, are all stretched out and spread one above another upon the same inclining plane, and have the same line of bearing and of declivity.

Inflam-
mables.

X. The mineral phlogiston or bitumen, united with the vitriolic acid: sulphur or brimstone. See the article SULPHUR.

This is very common in the earth, and discovers itself in many and various forms. It is found,

A. Native. *Sulphur nativum*.

In this the two constituent parts are mixed in due proportion in regard to each other, according to the rules of that attraction which is between them. It is easily known,

1. By its inflammability, and by its flame.
2. By its smell when burnt; and,

O 2

3. By

Inflam-
mables.

1. *Basaltes*. This is very common in Scotland, where it is frequently called *whin* stone; and at Borrowf-tounness there are several thick beds of it between the seams of coal. One of them being the immediate roof of a seam of coal there at Hillhouse lime quarry, there is a thin seam of coal beneath a beautiful bed of columnar basaltes. In the Bathgate hills to the southward of Linlithgow, also, there are several strata of coal blended with those of basaltes. These basaltine strata are always very hard, frequently very thick, and generally of a black or blackish grey colour. "There are but few people (says Mr Williams) sufficiently versed in natural history, to know that they are basaltes, as this kind of rock, both in England and Scotland, goes by the name of *whin* rock. In the north of Scotland it is called *skurdy*; and among the miners in Cornwall it has the name of *cockle* (b)."

2. Strata of *limestone* of various thicknesses are met with in different coal-fields. Sometimes the lime is the immediate roof; but sometimes there is an argillaceous stratum of about the thickness of a foot between the coal stratum and that of lime. In the coal-fields at Gilmerton, near Edinburgh, are several beds of limestone, some of them very good, and of considerable thickness. At Blackburn in West Lothian, also, there is a stratum of limestone six or seven feet thick, which is the immediate roof of a seam of coal about five or six feet thick. At Carlisle and Spittlehaugh in Tweedale, they have a seam of coal immediately below their lime quarries, which they work for burning their lime.

3. *Post-stone*, a kind of thick and solid stratum of free stone, is one of the roofs of coal, generally without the intervention of any argillaceous stratum, though sometimes a stratum of this kind is interposed. Frequently this kind of stone is rendered very hard by a mixture of iron or pyrites. In most coal fields, thinner strata of free stone are met with as the roofs of coal seams.

4. *Dogger-band*, as it is called by the Scots colliers, is frequently met with as the roof of coal seams. This name is applied to various substances. Sometimes they call strata of iron-stone *dogger bands*; sometimes the name is restricted to the ball iron-stone; sometimes to pyrites; and sometimes the dogger band is a kind of imperfect stone, composed of several heterogeneous mixtures, among which pyrites bears a considerable proportion, and by which the whole is so strongly bound together, that it is frequently very difficult to break through it.

5. *Whin-stone*, properly so called, not of a basaltic nature. These roofs are always very hard, and of various colours, as black, blackish grey, brown, red, &c. sometimes not above two or three feet in thickness, but sometimes much more.

6. *Post-stone*, of a softer nature than that already mentioned. This has no mixture of ferruginous matter.

7. *Regular strata of free-stone*, of various colours, textures, and thicknesses, but not sufficiently thick to deserve the name of *post-stone*, which our author thinks they do not, unless they are above three or four feet. These thin strata of free stone are very numerous in coal fields, and very frequently form the roofs of coal-seams. Some of them are three or four feet thick, while others do not exceed three or four inches. They make good roofs, easily cut through, and may be readily quarried out for other purposes.

8. *Grey-bands*, or grey-coloured free-stone, frequently form the roofs of coal seams. A great number of them are generally arranged in one place, lying immediately above one another; and they are frequently found of all degrees of thickness from one to twenty inches, though the most common dimensions are from two to six. By the Scots colliers these are called *grey sekas* as well as grey bands. Frequently they are found of moderate hardness, and sufficiently strong to make good flags and covers for sewers. These roofs are strong and safe when the stone partakes of the nature of the coal, and has a black or blackish grey colour; but when they have a mixture of tilly or argillaceous matter, they are more friable.

9. *Blaes*, when hard, strong, and well stratified, are reckoned tolerably good coal-roofs. These are always of a bluish-black or black-grey colour, and are of great variety in respect to hardness and strength. Some of the strongest and hardest are either entirely black or greyish black; while some of the different shades of black are pretty thick, and others are but thin. The thickest, however, are not above 18 inches, and the thinnest two or three inches or less. The medium thickness is from one foot to three or four inches. Some of them are sufficiently hard to make a good and safe coal-roof; but they seldom acquire such a degree of hardness as to give any considerable obstruction in sucking. All of them seem to have a considerable quantity of black argillaceous matter in their composition; and the strong blaes have also a considerable quantity of sand; often also containing a large portion of empyreumatic oil, and sometimes have a considerable mixture of coaly matter. There is a great variety both in the thickness and quantity of these blaes found above seams of coal. In some places the thinnest strata make the immediate roof; in others, the thickest. Sometimes we find only five or six inches of blaes upon the coal; in others as many fathoms, or even much more; and it is common to find them of all the intermediate thicknesses.

10. *Whitish*

(b) We must observe, however, that according to Bergman and other eminent mineralogists, the *cockles* or *shirls* ought not to be confounded with *basaltes*; which last name does not at all fit those substances. See *Volcanic Products* in the Appendix to this article.

3. By its producing a liver of sulphur, when mixed with a fixed alkali, like that made from artificial sulphur. It is found,

a. Pellucid, of a deep yellow colour.

b. Opaque, white, and greyish.

These are found in Siberia, at Bevioux in Switzerland, and at Solfatara near Naples.

c. Crystallised in octoedral prisms, with blunted points.

d. Transparent. Mr Davila had been informed that this was brought from Normandy in France. (*Brun.*)

1. Native sulphur is found in different forms, viz. either in solid pieces of indeterminate figure, running in veins through rocks; or in small lumps, in gypsum and lime-stones; in considerable quantities at Solfatara, and in the neighbourhood of volcanoes; or crystallised in pale, transparent, or semitransparent, octagonal, or rhomboidal crystals, in the cavities of quartz; and particularly in the matrices of ores; or in the form of small needles over hot springs, or near volcanoes (*Kirwan*).

Some-

10. *Whitish and ash-coloured argillaceous strata*, of middling strength, are frequently found to be the immediate roofs of coal. Some of these are of middling thickness, others thin. They are commonly found from two inches to two feet in thickness. A great many of these roofs are very dangerous on account of their fragility; while others are quite safe, owing to the more perfect formation of their strata, or to some ingredient in their composition.

11. *Streaked roofs*. These are of two sorts: 1. Such as are composed chiefly of sand, with a very small mixture of clay and blaes; and, 2. Those composed principally of clay or blaes with a small quantity of sand. Some of these have large, others small, streaks or ribs. Mr Williams says that he has seen them so beautifully streaked as to resemble the finest striped cotton stuffs. These stripes or streaks always lie exactly parallel to one another, as well as to the bed of the stone, and are always spread out the whole breadth of the stratum. Their colours are various in different strata, some of the stripes being nearly black and white, others white and red, and others yellow and red. In some the stripes appear of a lighter and darker grey colour. Some of the finely striped stones have their streaks about a quarter of an inch in diameter; sometimes less: and it is common to see stripes from a quarter to three quarters of an inch broad; but in the finely striped stones it is rare to find them a full inch thick without some different shade on one side or other of the stripe. The second kind of these streaked roofs, viz. such as are composed of blaes, with a smaller mixture of sand, differ but little from the former; only the colours are not always so bright, nor the stripes so fine; neither is the roof quite so hard.

12. *The soft blue roofs* sometimes consist of pretty thick strata; others of such as are thin or of middling thickness. There are likewise arrangements or classes of regularly stratified blaes, found immediately above seams of coal, from three or four inches to several fathoms in thickness, though some are even met with little exceeding one inch in thickness; though in the same place there might be a considerable thickness of blaes above the coal, taking in all the different strata, thick and thin, which lay above it. Some of these roofs have an oily appearance on the outside, and through all the fissures and joints of the strata; that is, they appear smooth and glossy, and are very slippery to the touch. Others have no appearance of this kind; but all of them are tender, weak, and fragile, so that they make a very indifferent and dangerous roof.

13. Another kind of coal-roof consists likewise of blaes, but such as are *imperfectly stratified*. It is altogether the same in quality and colour as the last, the only difference that can be distinguished being in the different degrees of stratification. The beds of this kind are not perfect, but unequal; whence it is a bad and dangerous roof, as great pieces of it are frequently apt to fall down by reason of the inequality and different joints of the strata. Some of these blaes appear in thick, and others in thin or middling thick beds; while some have an oily smoothness, called by the Scots colliers *creeshy* (greasy) blaes. It is owing to this oiliness particularly that these kinds of roofs are so dangerous; for the oil pervades the joints, and, rendering them slippery, makes the pieces more apt to fall out as soon as the coal is worked away from below them. Some of these have such a quantity of natural oil, that they will flame a little in the fire; and in some places there are hard blaes which will burn when fire is set to them, though they will not consume. At Pitsirran in Fifeshire there is a species of this blaes so inflammable, that when fire is set to one corner of a hillock it will burn throughout the whole; nevertheless it is not reduced in bulk by this combustion, nor does it produce any ashes. Instead of this it becomes considerably harder than before, and acquires a pale red colour. By reason of its hardness, it is proper for being laid upon horse and foot paths, but is not so for roads over which heavy wheel-carriages pass.

14. *Soft blaes not stratified at all*. Of these there is no more than one bed from two or three inches to several fathoms in thickness, without any others either above or below it. They are as common as any above the coal seams; but their substance is not always uniform throughout the whole stratum. Some of them are found divided into small angular masses, and others into larger ones; but whether these are uniform or not, they always make a bad and dangerous roof. These argillaceous strata are sometimes called *beds of till*; the uniform sort are called *dauk*, and the glebous kind *lipy* blaes, by the Scots colliers. Both the uniform and glebous soft blaes frequently contain a quantity of ball iron-stone, though some of it contains none at all. The regular continuous strata of iron-stone are commonly found in stratified soft blaes. There is a variety of soft coal-roofs of a grey colour, and of which some are regularly stratified, and some not.

15. Re-

Inflam-
mables.

- Sometimes it is formed in old privies: of this Mr Magellan saw some lumps that were found in a very old one at Paris.
2. United with clay in the aluminous ore of La Tolfa, and also at Tarnowitz in Silesia. This last resembles a light grey earth: when dry, bursts or cracks in the water like marl; and possesses a strong peculiar smell like camphor. If distilled, the sulphur sublimes. One hundred parts of this earth afford eight of sulphur, besides gypsum and a quantity of iron.
 3. Mixed with clay, iron, and selenite. This compound is of a grey, brown, or black colour, found near Rome, Auvergne, Spain, and Iceland.

4. With limestone in the form of a calcareous hepar. This is found at Tivoli, near Rome, and elsewhere in Italy. It is sometimes dissolved in mineral waters, three pounds of which contain as much as 25 grains of sulphur. It often forms incrustations on the brinks of these springs.
5. In the form of an alkaline hepar. This is said to be found in some waters in Russia; as will be hereafter noticed.
6. United to iron and clay of pyrites, &c. of which hereafter.
7. United to metallic substances, as hereafter specified.

Inflam-
mables.

B. Saturated with metals (F).

1. With iron. Pyrites, or copperas-stone; Pyrites.

15. *Regularly soft grey coal-roofs.*—Of these there are several sorts. Some have a considerable quantity of sand in the composition of the strata; and many of these are as regularly stratified as any coal-metals whatever. Numbers are found very thin, and others of middling thickness; though in all cases they are so tender and friable, that they make very bad and dangerous roofs. Some of them indeed look pretty well at first but they soon crumble and come down, especially when they have been exposed to the air. This, in the opinion of Mr Williams, is owing partly to their having too much clay in their composition, and partly to the want of a sufficient quantity of natural cement to connect the several particles of the stone together.

16. *Soft grey regular strata, or grey bands of an argillaceous kind;* and of these there is likewise a considerable variety. Some are of a dark, others of a lighter grey; some thick, others thin: they are very numerous in coal-fields, and are frequently to be found as the immediate roofs of coal. These, as well as the black kinds, are found in all quantities or degrees of thickness above different coals, from a few inches up to several fathoms; but whether they be in great or small quantity, the roof they compose is generally very frail and tender.

17. *Soft grey argillaceous bands, imperfectly stratified.* These differ little or nothing in substance from the former; the only difference is in the stratification. Many of the strata of the former are of a middling thickness, or rather thin, finely and regularly spread out, and every part of each stratum of an equal thickness. But this sort, though it has the appearance of strata, is clumsy and irregular; that is, the several beds are unequal, and divided by many irregular joints into unequal misshapen masses, which makes this a very bad roof; the masses being apt to separate at the joints, and to fall down when the coal is worked out from below them.

18. *Soft grey argillaceous beds of metal or coal roofs not stratified at all.* These are of two kinds, viz. 1. such as are found broken or formed in the stratum into glebes or masses; and, 2. such as are found in one uniform mass throughout the whole bed, without any division into masses or strata. These grey soft roofs are of all degrees of thickness, from a few inches up to many fathoms, as well as the black; and there is but very little difference between them in any respect excepting the colour. But in this, as well as in the black unstratified blaes, and that both in the glebeous and uniform beds, ball or glebeous iron-stone is frequently found; and strata of iron-stone are also found in the stratified soft grey blaes.

19. *White and ash-coloured soft argillaceous coal-roofs;* and of these there is also a great variety. Some of this kind are regularly stratified, others imperfectly, and some not at all. Some of the whitish argillaceous roofs are compounded of gritty sand and clay; others appear to be chiefly composed of pure clay; and some of a loamy clay. Those which are regularly stratified and mixed with sand, either coarse or fine, are of great variety with regard to thickness and the arrangements of the strata; but all of them are tender and fragile, and thus make very troublesome and dangerous roofs.

20. *Whitish argillaceous roofs, stratified,* and of a homogeneous quality, or not mixed with sand. Some of these are finely and perfectly stratified, and are of different degrees of hardness; but in general, make but a weak roof. Some of them are found in irregular strata, with all the other varieties and imperfections already mentioned.

21. *White and ash-coloured argillaceous coal-roofs, not stratified at all.* Sometimes these are found in very thick beds in the coal-fields; and some of these, as well as of the black soft roofs, rise in glebes and masses of different sizes; while others are homogeneous throughout the whole bed, however thick, from two or three inches to several fathoms. Some of these beds of white argillaceous marle-like matter are found to be a sandy or loamy clay; others a pure homogeneous clay, which does not feel gritty between the fingers nor in the mouth. The shades and varieties of this kind are as numerous as those of any of the foregoing; and all of them, by the Scots colliers, are called *dauk*, whatever be their colour. Mr Williams informs us, that he has frequently taken some of these fine white clays to wash his hands, and has found them answer almost as well as soap.

(F) Sulphur is the most common mineralifer of metals; and therefore most of its combinations with those substances fall to be ranked hereafter among the metallic ores.

rites. This is the substance from which most sulphur is prepared, and is therefore ranked here with all its varieties. It is hard, and of a metallic shining colour.

A. Pale yellow pyrites; *Pyrites subflavus*. Marcasite. This is very common, and contains a proportionable quantity of sulphur with respect to the iron; when once thoroughly inflamed, it burns by itself.

a. Of a compact texture; *Polita piedra del yuca, Hispanorum*.

b. Steel-grained.

c. Coarse-grained.

d. Crystallised. It shoots mostly into cubical and octoedral figures, though it also crystallises into innumerable other forms.

B. Liver-coloured marcasite. Its colour cannot be described, being betwixt that of the preceding marcasite and the azure copper ore. The iron prevails in this kind; it is therefore less fit to have sulphur extracted from it, and also for the smelting of copper ores. It is found,

a. Of a compact texture.

b. Steel-grained.

c. Coarse-grained.

C. Various combined with iron and other metallic substances.

1. With iron and copper; forming yellow or marcasitical copper ore.

2. With iron, silver, and lead; potters lead ore.

3. With iron and zinc; mock lead, black jack or blende.

4. With iron and arsenic; arsenical pyrites.

5. With iron and cobalt.

6. With iron and bismuth.

7. With iron and nickel.

8. With iron and gold; pyritical gold ore.

9. With silver; glass silver ore.

10. With copper; grey or vitreous copper ore.

11. With lead; potters lead ore.

12. With bismuth.

13. With quicksilver; cinnabar.

14. With arsenic; orpiment, realgar.

XI. Mineral phlogiston mixed with metallic earths.

This is not found in any great quantity: in regard to its external appearance, it resembles pit-coal; and the fat substance contained in it, at times, partly burns to coal, and partly volatilises in a calcining heat.

The only known varieties of this kind are,

A. *Minera cupri phlogistica*.

When it has been inflamed, it retains the fire, and at last burns to ashes, out of which pure copper can be smelted.

B. *Minera ferri phlogistica*.

This is not very different in its appearance from the pit-coal or fossile pitch, but it is somewhat harder to the touch. There are two varieties of this species:

1. Fixed in the fire; *Minera ferri phlogistica fixa*.

Exposed to a calcining heat, it burns with a very languid though quick flame; it preserves its bulk, and loses only a little of its weight. It yields above 30 per cent. of iron.

a. Solid, which resembles black sealing-wax.

b. Cracked, and friable.

2. Volatile in the fire.

This is unalterable in an open fire, either of charcoal, or even upon a piece of charcoal before the flame of the blow-pipe; but under a muffle the greatest part of it volatilises, so that only a small quantity of calx of iron remains. It is found,

a. Solid.

b. Cracked.

This last kind leaves more ashes: these ashes, when farther exposed to the fire, become first yellowish-green, and afterwards reddish-brown; when, besides iron, they then also discover some marks of copper: it has, however, not been possible to extract any metallic substance from them, the effects of the loadstone, and the colour communicated to the glass of borax, having only given occasion to this suspicion.

CLASS IV. METALLIC SUBSTANCES.

METALS are those minerals which, with respect to their volume, are the heaviest of all known bodies. Some of them are malleable; and some may be decomposed; and, in a melting heat (c), be brought back again to their former state by the addition of the phlogiston they had lost in their decomposition. See METALLURGY, Part I. Sect. i. and CHEMISTRY-Index at *Metallic Calces* and *Metals*.

All the metallic substances contain phlogiston; and when, to a certain degree, deprived of it, fall into a powder like an earth; but their attractions for phlogiston are different.

Most of them, when melted in a common way, and exposed to the air, have an earthy crust formed upon the surface, which cannot again be reduced to metal without the addition of some inflammable matter. The base metals have this property.

But the noble metals, viz. platina, gold, and silver, are so firmly united to the phlogiston, that they never calcine under fusion, however long continued; and, after being changed into a calx in the liquid way, when melted in the fire, they reassume their metallic form without any other phlogiston than what is contained in the matter of heat.

Quick-

(c) The various degrees of heat required to reduce metals to a fluid state, are seen in the following table, which was extracted, for the most part, by Dr Withering, from the printed treatises of the late celebrated Professor Bergman. It exhibits, in a simple view, 1. The specific gravity of each metal; 2. The degree of heat by Fahrenheit's scale, in which it melts; 3. The quantity of phlogiston it requires for its saturation; and, 4. Its

METALS.

Quicksilver holds a kind of middle place: for, like the base metals, it may be calcined, though not readily; and, like the noble ones, it may be reduced by heat alone.

We may therefore reckon four noble or perfect metals; viz. gold, platina, silver, and mercury; because, when calcined, they recover their phlogiston without the addition of any phlogistic substance.

But as tin, lead, copper, and iron, cannot be reduced without such addition, these are called *ignoble* and *imperfect* or *base* metals. *Kirwan's Mineralogy.*

However, all those eight metals (even mercury, when solid) are malleable to a considerable degree, and are called *entire* metals. But

Bismuth, zinc, antimony, arsenic, cobalt, nickel, manganese, molybdena, and wolfram, are scarce at all malleable, and hence they are called *semimetals*. Nevertheless, zinc and purified nickel are more malleable than any of the other semimetals; so that we have four perfect or noble metals, four imperfect or base, eight entire, and nine semimetals (H).

Order

4. Its attraction to the same saturating phlogiston. We must, however, observe, that if the second column be compared with that of Wedgwood's thermometer, their great disagreements betray some fundamental error in the assumed data: for the degrees of heat assigned by Mr Wedgwood for melting gold, silver, and copper, are more than quadruple of those assigned by Bergman, and that for melting iron is more than eleven times greater; although they both nearly agree in the red heat of iron, which Bergman says to be 1050 degrees, and Wedgwood 1077. Mr Magellan is of opinion, that the fault lies in Mortimer's thermometer, which Bergman quotes with some diffidence (Sect. 197. of his *Sciagraphia*); and thinks it probable, that the changes caused by heat, on this metallic thermometer, are in a much less increasing proportion by intense fire, than those indicated by the contraction of the pure clay, happily employed by Wedgwood in his thermometer. He therefore added another column to this table, marked *Wedgw.* with the degrees of the melting heats already ascertained by this last thermometer, as being the nearest to truth.

METALS.	Specific Gravity.	Melting Heat. Berg.	Melting Heat. Wedgw.	Saturating Phlogiston.	Attraction to saturating Phlogiston.
Gold	19,640	1301	5237	394	1 or 2
Platina	21,000			756	1 or 2
Silver	10,552	1000	4717	100	3
Quicksilver	14,110	—40	—40	74	4
Lead	11,352	595		43	10
Copper	8,876	1450	4587	312	8
Iron	7,800	1601	17977	342	11
Tin	7,264	415		114	9
Bismuth	9,670	494		57	7
Nickel { common }	7,000	1301		156	11
{ pure }	9,000	1601		109	5
Arsenic	8,308				
Cobalt { common }	7,700	1450			
{ pure }		1601			
Zinc	6,862	699		182	11
Antimony	6,860	809		120	6
Manganese	6,850	Very great		227	11

N. B. By saturating phlogiston, Professor Bergman means to express the proportionate quantities taken away from each metallic substance, when dissolved by means of acids, and of course reduced to a calciform state. The last column only expresses their attraction to this part of their phlogiston, not to that which still remains united to them in a calciform state. *Withering.*

(H) Mr Mongez remarks, that the following are the general properties of metals, when considered as physical bodies; viz. their opacity, great specific gravity, ductility, tenacity, crystallization, flavour, and even smell, at least in some of them.

It is from their density that their gravity and opacity proceed; this last being such, that, even reduced to the thinnest plates, no rays of light can pass through their particles, unless there remains an interstice or pore quite free from the metallic substance. Gold leaf must, however, be excepted, which exhibits a fine green by transmitted light.

As to their crystallization, it has been found to take place whenever they are pure, and left to cool very slowly by themselves, after having been perfectly fused. (See *Journal de Physique* for July 1781, p. 74.) The flavour and smell above mentioned are very perceptible in the reguline substances of arsenic and antimony, as well as in lead, copper, and iron.

All metals are conductors of electricity; and more perfectly so than any other bodies during their union with phlogiston.

They

METALS.
Gold.

Order I. NOBLE OR PERFECT METALS.

- I. Gold; *Aurum sol chymicorum*. See the articles GOLD; also CHEMISTRY-Index; and METALLURGY, Part II. sect. 1.

This is esteemed the principal and first among the metals; and that partly for its scarcity, but chiefly for the following qualities:

1. It is of a yellow shining colour.
2. It is the heaviest of all known bodies, its specific gravity to water being as 19,640 to 1000.
3. It is the most tough and ductile of all metals; because one grain of it may be stretched out so as to cover a silver wire of the length of 98 yards, by which means $\frac{1}{100000}$ of a grain becomes visible to the naked eye.
4. Its softness comes nearest to that of lead, and consequently it is but very little elastic.
5. It is fixed and unalterable in air and water, and is indestructible by the common action of fire.

No 223.

6. When melted, it reflects a bluish-green colour from its surface.

7. It dissolves in aqua-regia, in the dephlogisticated marine acid, and also (according to Crell †) in an acid obtained by distilling vitriolic acid from off manganese. *Journal de Physique, Oct. 1784. p. 297.*

8. When mixed with a volatile alkali and a little of the acid of nitre, by means of precipitation out of aqua-regia, it burns off quickly, in the least degree of heat, with a strong fulmination.

9. It is dissolved, in *forma sicca*, by the liver of sulphur, and also somewhat by the glass of bismuth (r).

10. It is not carried away by the antimony during the volatilisation of that semi-metal, and is therefore conveniently separated from other metals by the help of crude antimony; in which process the other metals are partly made volatile, and fly off with the antimony, and partly unite with the sulphur, to which the gold has no attraction, unless by means of some uniting body, or by a long digestion (κ).

II. The

They are soluble either in nitrous acid and in dephlogisticated marine acid, or in aqua regia; and are precipitable in some degree by caustic alkalies; and except platina by the Prussian alkali.

When dephlogisticated, they communicate a tinge to borax and to microcosmic salt, or at least render them opaque.

They assume a convex surface when melted, and even a globular form, if in a small quantity; and though they mix for the most part with one another whilst fused, yet they refuse to unite with unmetallic substances, even their own calces, iron only excepted, which does to its own calx slightly dephlogisticated and to plum-bago. Nickel also, and some others, may contain sulphur in their reguline state.

Metals, when calcined, are capable of uniting with other calces and salts.

Three of the metallic calces have been found to be of an acid nature; viz. the arsenical, molybdenic, and tungstenic; from which, by analogy, the nature of other calces may be conjectured.

The phlogiston contained in metals is in a pure state; viz. without water and aerial acid, with which it is invariably accompanied in all other compounds except acid airs and sulphur.

When metallic substances are naturally found in the earth united to their full share of phlogiston, and consequently possessing their peculiar properties, they are called *native*.

But when they are found more or less deprived of their phlogiston and of their properties, combined with other substances, they are then called *mineralised*. This is the most common state of the mineral kingdom. The substance so combined with them is called the *mineraliser*, and the whole is called *ore*; by which name are also distinguished these earths and stones in which metallic substances are contained.

But if both metallic substances are mixed together in their metallic or reguline form, without the loss of phlogiston, they are then said to be alloyed.

When the mineraliser is of a saline nature, and renders the metallic combination soluble in less than 20 times its weight of water, the compound is ranged among salts. Thus the vitriols of iron, copper, and zinc, are rather classed with salts than with ores.

The most common mineralisers are, sulphur, arsenic, and fixed air or aerial acid. The least common are the vitriolic and the marine acids. The phosphoric has been found only in two instances; viz. united to lead, discovered by Gahn; and to iron, in the siderite, as Mr Meyer believes.

Those metallic substances, mineralised by aerial acid, are called *calceiform ores*.

M. Magellan observes, that if the new doctrine of the French chemists, who assert, that calces of metals are a compound of dephlogisticated or vital air with the metallic substance, were just, all calceiform ores should produce this vital air instead of aerial acid, when they are reduced to their metallic form; which is not the case: neither should all the base metals and semimetals absolutely require the mixture of some phlogistic substance in order to their being reduced from the state of calces to their metallic form, which otherwise would be quite useless, if their reduction simply consisted in their separation from the vital or dephlogisticated air.

(1) Neither sulphur nor fixed alkali has any action on gold; but the liver of sulphur, which is a compound of both, can dissolve it in the dry way; so that if a proper quantity of gold-leaves be put in a crucible together with liver of sulphur, and it be melted in a brisk fire, the gold is thoroughly dissolved; and if the whole be diluted in water, the gold will be kept in the solution, and even pass through the filtre along with it.

(κ) Antimony is used also to refine gold from its alloy, as it attenuates and carries off all other metallic substances

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Gold.Perfect
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Silver.

11. The phosphorus is said to have ingress into gold (L).
 12. If mixed with a less portion of silver, platina, copper, iron, and zinc, it preserves tolerably well its ductility. But,
 13. When mixed with tin, it becomes very brittle; and it attracts likewise the smoke of that metal, so as to be spoiled if melted in an hearth where tin has been lately melted (M).
 14. It requires a strong heat before it melts, nearly as much or a little more than copper.
 15. It mixes or amalgamates readily with quicksilver. See METALLURGY, Part II. sect. i. (N).
 16. It is not dissolved by the glass of lead, and therefore remains on the cupel.
- A. Native gold. With respect to the figure or the quantity in which gold is found in one place, it is by miners divided into,
1. Thin superficial plated or leaved gold; which consists of very thin plates or leaves, like paper.
 2. Solid or massive, is found in form of thick pieces.
 3. Crystallised, consists of an angular figure.
 4. Wash gold, or gold dust, is washed out of sands, wherein it lies in form of loose grains and lumps (O). See other distinctions of form under the article GOLD.
- B. Mineralised gold. This is an ore in which the gold is so far mineralised, or so entangled in other bodies, as not to be dissolved by the aqua-regia.

1. Mineralised with sulphur by means of iron. Marcasitical gold-ore; *Pyrites aureus*.

2. By means of quicksilver. It is found in Hungary.

3. By means of zinc and iron, or silver. The Schemnitz blende.

See other varieties of mineralised gold ores under the detached article GOLD, already referred to.

II. Silver: *Argentum, Luna*. See the article SILVER. See also CHEMISTRY-Index; and METALLURGY, Part II. sect. iii. and Part III. sect. iii.

This metal is,

- a. Of a white shining colour.
- b. Its specific gravity to water is, according to Cronstedt, as 11,091 to 1000; according to Bergman, = 10,552; and according to Kirwan, 11,095.
- c. It is very tough or ductile, so that a grain of it may be stretched out to three yards in length and two inches in breadth.
- d. It is unalterable in air, water, and fire.
- e. It dissolves in the acid of nitre, and also by boiling in the acid of vitriol.
- f. If precipitated out of the acid nitre with the common salt, or with its acid, it unites so strongly with this last acid, that it does not part from it, even in the fire itself, but melts with it into a mass like glass, which is called *luna cornea* (P).

P

3. It

Substances mixed with it, without excepting the silver; whilst lead leaves this last behind, and even adds some of its own to the gold. *Pauſon*, p. 659.

(L) Gold, reduced into thin leaves, is not acted upon by the phosphoric acid in the humid way, though the fire be urged till luminous decrepitations take place; but when it passes that point which separates the humid from the dry way, Mr Margraaf observed that some purple scoria were formed, which is an indication that this concrete acid had partly calcined the gold during its fusion. *Elements de Chymie de Dijon*, Vol. III. p. 131.

Besides this, a drop of the phosphoric acid on the solution of gold by aqua-regia precipitates the metal in its revived state, as asserted by the academicians of Dijon. *Magellan*.

(M) The fumes of a single grain of tin are capable of rendering hard eight ounces of gold; but it easily recovers its malleability by being melted on the fire. (*Wallerius* and *Bomare's* Mineralogy.) But when gold is mixed with arsenic, cobalt, nickel, bismuth, or with the regulus of antimony, it only loses great part of its malleability; and when in a certain proportion, it may be calcined and vitrified with them.—(*Fabroni*.)

(N) Bergman doubts if ever gold has been found perfectly pure; and Mr Kirwan says that it is very seldom found so, being generally alloyed with silver, copper, or iron, or all three. As to the gold commonly used in toys and other objects of luxury, every one knows that it is purposely debased by the artists with copper or other metals; and of late it has been employed in various pieces of jewellery, to form ornaments of various colours: thus a great alloy of silver (viz. one-third part), gives it a shade of a green colour; a similar quantity of copper, a reddish one; a mixture of arsenic, or filings of steel, in the proportion of one-fourth part, gives it a bluish cast; so that having the yellow naturally in the pure gold, and the white in pure silver, the jewellers have almost all the colours to diversify their work. Even in the currency of money, there is none coined out of pure gold, which, by common agreement, is called *gold of 24 carats*. The gold coin of England, France, and Portugal, only contains 22 parts of pure gold, and two of alloy, viz. it is only 22 carats, in the common saying: that of Spain is but of $21\frac{1}{2}$ carats: but the ducat of Holland is of $23\frac{1}{2}$ carats; and the zecchino of Venice, of $23\frac{1}{2}$ carats: which last therefore, it would seem, is the purest gold coin of Europe. (*Pauſon's Metrologie*.)

(O) M. Daubenton, in his Methodical Tables of Minerals, enumerates eight sorts of native gold, viz. 1. In powder; 2. In grains; 3. In small spangles; 4. In masses of lumps; 5. In filaments; 6. In branches like vegetables; 7. In lamella; and 8. In octoedral crystals.—He observes also, that gold, in its reguline state, is formed, either, 1. Into angular crystals, composed of yellow octoedres; or, 2. Into irregular yellow masses, which, being broken, show a granular substance.

(P) The marine acid attracts the calx of silver, but cannot remove its phlogiston; and therefore cannot dissolve

g. It does not unite with the semi-metal nickel during the fusion.

b. It amalgamates easily with quicksilver.

i. It is in the dry way dissolved by the liver of sulphur.

k. It has a strong attraction to sulphur, so as readily to take a reddish yellow or black colour when it is exposed to liver vapours.

l. It has no attraction to arsenic; whence, when the red arsenical silver ore, or *rothguldener ertz* of the Germans, is put into the fire, the arsenic flies off, and leaves the sulphur (which in this compound was the *medium uniens*, behind, united with the silver in form of the glass silver ore, or glass ertz.

m. It is not dissolved by the glass of lead, and consequently it remains on the cupel.

n. It is exhaled or carried off by volatile metals and acids; as by the vapours of antimony, zinc, and the acid of common salt.

o. According to Cronstedt, it melts more easily than copper; and this was a general opinion. But the contrary, as Mr Magellan remarks, has been proved by means of the nice thermometer lately invented by Wedgewood.— See THERMOMETER.

Silver is found,

A. Native or pure; which most generally is nearly of 16 carats standard (Q.)

1. Thin, superficial, plated or leaved.

2. In form,

a. Of snaggs, and coarse fibres.

b. Of fine fibres. Capillary silver.

c. Arboresecent.

d. Crystalline or figured. This is very rare; it has distinct fibres, with shining surfaces.

B. Mixed or alloyed with other metals.

The following are the known instances of these mixtures:

1. United to gold, (*Bergman's Sciagraphia*, § 154.)

2. Mixed with copper; (*Berg. Sc.* § 155.)

3. United to gold and copper; (*Berg. Sc.* § 156.)

4. Amalgamated with mercury, found in the mines of Salberg; (*Foster's notes to Brunnich*.)

5. United to iron; (*Berg. Sc.* § 157.)

6. United to lead, sometimes in such quantities as to be worth the expences attending the separation.

7. United to arsenic; (*Journal de physique*, 1778, p. 50.)

8. United to antimony; (*Berg. Sc.* § 159.)

9. Joined to the regulus of arsenic and iron; (*Berg. Sc.* § 160.)

10. Mixed with the alkaline limestone from

Annaberg, described by Mr Just; (*Brunnich*.)

11. Sandy silver-ore, without any metallic shining.

12. Silver-ore in a red-brown schistus, described by Lehman: it is composed of argillaceous earth, micaceous hematites, sulphur, calcareous spar, fluor mineralis, lead, and silver.— It contains about seven or eight ounces of silver on the hundred weight.

13. Soft silver-ore. It is found among the marles and argillaceous earths; and is of various colours, either singly or mixed.

C. Dissolved and mineralised.

(1.) With sulphur alone. Glass silver-ore.

This is ductile, and of the same colour as lead; but, however, becomes blacker in the air. It has therefore, though very improperly, got the name of *glass-ore*; for that name rather belongs to the *minera argenti cornea*, or horn silver ore, if indeed any silver ore can be considered as glassy.

It is found,

1. In crusts, plates, or leaves.

2. Grown into

a. Snaggs, and

b. Crystalline figures.

It is generally either of a lamellar or a grained texture.

The glass silver ore is the richest of all silver ores; since the sulphur, which is united with the silver in this ore, makes but a very small quantity of its weight.

(2.) Arsenico-martial silver ore, (*Weill ertz*, Germ.)

This ore contains silver and iron mineralised by arsenic; the arsenic in a larger proportion than the iron. This is the *Pyrites argenteus* of Henckel.

1. It is a hard substance, of a white shining appearance, and of a compact, lamellar, or fibrous texture. (*Kirwan*, sp. 7.)

2. Of a yellowish white colour, and of a striated structure, resembling bismuth, but much harder. (*Kirwan*, sp. 3.)—It is found near Guadanal canal in Spain.

3. Near the same place is found also another ore of the same kind, which is very soft and easily cut; and when cut, has a brilliant metallic appearance. It consists of conchoidal laminæ. The quintal contains only from four to six ounces of silver; but it is easily reduced by evaporating the arsenic, which then leaves the silver slightly contaminated with iron. (*Kirwan*, sp. 4.)

(3.) With

dissolve it in its metallic state, (*Bergman*.) However, the marine acid, if well concentrated, or rather reduced into an aerial form, dissolves silver in its metallic state, (*Fabroni*.)

Mr Scheele, and after him Mr Bertholet, assert positively, that the marine acid, being dephlogisticated by its distillation over manganese in the form of a yellow air or gas, dissolves all the metals, without excepting gold, silver, or mercury. See Scheele's Essay 5. § 25. H.

The vitriolic acid being distilled also over the manganese, dissolves silver, gold, and mercury, as Dr Crell asserts, (*Journal de Physique*, Oct. 1785, p. 297.)

Silver is precipitated from the vitriolic and nitrous acids by the marine; and from the nitrous, in great measure, by the vitriolic, (*Kirwan*.)

(Q) Wallerius distinguishes seven species of silver: (see the article SILVER). Daubenton reckons eight varieties of *native white silver*, arising from their peculiar forms.

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Platina.

- (3.) With sulphur and arsenic. The red or ruby-like silver ore. The *rothguld* of the Germans.

The colour of this ore varies as the proportion of the ingredients varies in the mixture, viz. from dark grey to deep red; but when it is rubbed or pounded, it always gives a red colour.

- a. Grey arsenical silver ore.
1. Plated, cruited, or leaved.
2. Solid.
b. The red arsenical silver ore:
1. Plated, cruited, or leaved;
2. Solid or scaly.
3. Crystallised (R.)

In this last form it shows the most beautiful red colour, and is often semi-transparent. It contains about 60 per cent. in silver.

- (4.) With sulphur, little arsenic, and iron.—(*Schwarz ertz*, *Schwarz guld*, *Silber mulm*, Germ.)

This is a friable, weathered, decayed ore.

- a. Of a black or footy colour; and is therefore called by the Germans *silberschwartz*, or *ruffigtes-ertz*.

- (5.) With sulphurated arsenic and copper. The *weissguld* of the Germans.

This, in its solid form, is of a light grey colour, and of a dull and steel-grained texture. Its proportion of silver is from 10 to 30 per cent.

- (6.) With sulphurated arsenic and iron. The *weissertz*, or white silver ore of the Germans. This is an arsenical pyrites, which contains silver; it occurs in the Saxon mines, and so exactly resembles the common arsenical pyrites, as not to be distinguished from it by sight alone, or without other means.

- (7.) With sulphurated antimony.
a. Of a dark grey and somewhat brownish colour; the *laberetz* of the Germans.
b. Of a blackish blue colour.
1. In form of capillary crystals. *Federertz*, or plumose silver ore.

- (8.) With iron, arsenic, and cobalt, mineralised by sulphur.

This ore looks like the *weissguld* described above; but is distinguished by the rose coloured particles of cobalt, dispersed through dark brown, blackish, or grey, and sometimes shining solid mass. It is to this species of ores that the silver goose dung ore belongs.

- (9.) With sulphurated copper and antimony.—The *Dalshertz*.

This resembles both in colour and texture the

dark-coloured *weissguld*. When rubbed, it gives a red powder.

- a. Solid.
b. Crystallised.
(10.) With sulphurated zinc. The *pechblende* of the Germans.

This is a zinc ore, mock lead, or blende, which contains silver, and is found among rich silver and gold ores.

- a. Of a metallic changeable colour.
1. Solid, and with fine scales.
2. In form of balls. The *kugel-ertz*, or ball ore.
b. Black mock lead, or blende, found in Saxony. This is also found,
1. Solid, and with fine scales;
2. And in form of balls.

- (11.) With sulphurated lead; potters ore. *Galena*; *bleyglanz*.

- (12.) With sulphurated lead and antimony, called *striperz*.

- (13.) With sulphurated iron. *Silberhaltigier kies*; marcasite holding silver.

- (14.) With sulphurated and arsenical cobalt; dendrites being sometimes found in the stone. These kinds keep well in water; but generally wither in the air, and lose the silver they contain.

- (15.) Mineralized by sulphur, with regulus of antimony and barytes. The butter-milk ore. This is found in the form of thin particles, on granular spar, (*Kirwan*, sp. 13.)

- (16.) Combustible silver ore.
This is a black and brittle substance, and leave about 6 per cent. of silver in its ashes. It is in fact a coal in which silver is found. (*Kirwan*, sp. 14.)

- (17.) With the acid of common salt. *Minera argenti cornea*. *Hornetz*, or horn-silver ore.

This is the scarcest silver ore; it is of a white or pearl colour, changeable or varying on the surface, semi-transparent, and somewhat ductile both when crude and when melted. It cannot be decomposed without some admixture of such substances as attract the acid of sea-salt.

III. Platina del Pinto; *Juan blanca*.

This metal is a recent discovery of our times; and is described with great accuracy by Scheffer, in the Acts of the Royal Academy of Sciences at Stockholm for the year 1752; as also by Dr Lewis, in the Philosophical Transactions for the year 1754, vol. xlviii. and by many other writers. By these descriptions we are convinced of the resemblance this metal bears to gold; and therefore we must allow it to be called *white gold*. It has, however, a variety of distinguishing qualities

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(R) Wallerius mentions the six following varieties of this notable ore in his *Species* 388, viz. 1. The red opaque, like cinnabar, from Andreasberg in the Hartz, and from Salberg in Westmannia: 2. The bluish, from Freiberg and Annaberg: 3. The grey, from Freiberg and Andreasberg: 4. The red transparent amorphous, of the garnet colour, from Potosi and Joachimthal: 5. The red transparent, crystallised into prismatic decaedres, or dodecaedres, from Hungary, Alsace, and the Duchy of Deuxponts: 6. The only superficially red ore, from Salberg and Ehrenfriedrichsdorf.

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Quicksilver.

ities besides its colour, which ascertain its peculiar nature: All which, with its history, uses, &c. are particularly described under the detached article PLATINA. See also CHEMISTRY-Index; and METALLURGY, Part II. sect. ii.

1. It is of a white colour.
2. It is so refractory in the fire, that there is no degree of heat yet found by which it can be brought into fusion by itself, the burning-glass excepted. But, when mixed with other metals and semimetals, it melts very easily, and especially with arsenic, both in its metallic form and in form of a calx or glass.

IV. Quicksilver, mercury. *Hydrargyrum, Argentum vivum, Mercurius.* See the article QUICKSILVER; CHEMISTRY-Index, at Mercury; and METALLURGY, Part II. sect. viii.

Mercury distinguishes itself from all metals by the following qualities (s.)

- a. Its colour is white and shining, a little darker than that of silver.
- b. It is fluid in the cold, and divisible by the least

force; but, as it only sticks to a few bodies to which it has an attraction, it is said that it does not wet.

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- c. It is volatile in the fire.
- d. It attracts the other semimetals and metals; and unites with them all except cobalt and nickel, with which it cannot by any means yet known be made to mix. This union is called *amalgamation*. This amalgamation, or mixture of metallic bodies, according to the readiness with which they unite or mix, is in the following progression, viz. gold, silver, lead, tin, zinc, bismuth, copper, iron, and the regulus of antimony; the three latter, however, do not very readily amalgamate. The iron requires a solution of the vitriol of iron, as a medium to promote the union.
- e. It dissolves in spirit of nitre, out of which it is precipitated by a volatile alkali, and common salt, in form of a white powder; but if a fixed alkali is used, a yellow powder or calx is obtained (r).

f. But

(s) It were almost superfluous, says Mr Kirwan, to mention any other character of quicksilver than its liquidity, to distinguish it from other metals. In regard to this property, Bergman observes, that mercury constitutes one extreme among the metals, and platina the other; since it requires to be melted only such a degree of heat as is rarely wanting in our atmosphere, and boils at the 6000 degrees nearly after lead melts. See the table at p. 111. *Note.* But when the cold is increased to the temperature denoted by 40 degrees below 0 both of Fahrenheit's and of the Swedish thermometer, which both coincide in that point (since $212 - 32$, or $180 : 100 :: 32 + 40$, or $72 : 40$), this metal concretes like any other metal, and becomes quite solid; (see Philosophical Transactions for 1783, p. 303.) Mercury in its common state, therefore, according to Bergman (*Treatise of Elea. Attra.*), is to be considered as a metal in fusion: and since in its solid state it is nearly as malleable as lead, it by no means ought to be placed among the semimetals, otherwise every other entire metal should be considered as brittle, for none is malleable when in fusion.

(r) 1. Mercury is dissolved with great rapidity by nitrous acid: the liquor is of a greenish-blue colour, but loses it afterwards and becomes limpid. This solution, when made without heat, is used as a test for the analysis of mineral waters, and has different properties from that made with the help of heat. In the first case, says Bergman, very little phlogiston is lost, and the salt easily crystallises, being white, and scarcely acid. It is not precipitated by distilled water; but by caustic vegetable alkali, it is precipitated of a yellowish colour; by mild alkali, the precipitation is white; by mineral alkali, it is yellow, but it soon grows also white; by volatile alkali, it turns to a greyish-black colour; by Glauber's salt, or by pure vitriolic acid, the precipitation is white, granulated, and in a small quantity; nor, if this precipitant has been sparingly used, does this colour appear in less than an hour: by muriatic acid, or common salt, the precipitation is also white, but in a large quantity, and in curdles.

2. But if the mercurial solution be put over a sand-heat, it may be charged with a quantity of mercury equal almost to its weight. According to the chemists of Dijon, 10 ounces of nitrous acid may dissolve eight of mercury. The action of the solvent becomes stronger with the heat; emits great quantity of vapours; and if not taken from the fire, will be too far evaporated. Distilled water will precipitate from this solution a white calx, because it is more dephlogisticated, and the solvent is overcharged with it; and the water changing the density of the liquor, diminishes the adhesion of the calx, as Fourcroy remarks. This white calx will turn yellow, if boiling water be poured on it. The vegetable alkali precipitates it of a brownish yellow, which by degrees assumes a pale-yellow tinge: the mild vegetable, and the mineral alkalies, produce nearly the same colour; though when this last is employed, the colour turns afterwards to white. The precipitation by volatile alkali is quite white also; that by the vitriolic acid is yellow; and, finally, a copious white mucilaginous matter is the precipitate by the marine acid.

3. This solution by nitrous acid is very caustic; corrodes and destroys animal substances; when it falls on the skin, stains it of a deep purple brown colour, which appears black: the stains do not go off before the separation of the epidermis, which falls away in scales or kind of scars. It is used in surgery as a powerful escharotic, and is called *mercurial water*.

4. The same solution, by cooling, is susceptible of forming crystals, which vary from one another according to circumstances: for the most part they are like needles; are very caustic; redden the skin; and detonate when put on burning coals, provided they be dry. They are called *mercurial nitre*, which fuses when heated in a crucible; exhales reddish fumes; assumes a deep yellow colour, which afterwards turns to orange, and

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Quicksilver.

- f.* But it requires a boiling heat to dissolve it in oil of vitriol (v).
g. It is not affected by the acid of common salt, unless it be previously dissolved by other acids (v); in which case only they both unite with one another, and may be sublimed together; this sublimate is a strong poison.
h. It unites with sulphur by grinding; and then produces a black powder called *æthiops mineralis* (w), which sublimes into a red striated body called *falsitious cinnabar*.
i. The sulphur is again separated from the quicksilver, by adding iron or lime, to which the sulphur attaches itself, leaving the quicksilver to be distilled over in a metallic form; but if a fixed alkali be used, some part of the quicksilver will remain dissolved in the residuum, which is a liver of sulphur.

Quicksilver is found,

- A.* Native, or in a metallic state. *Mercurius natus*, or *virginicus*.

This found in the quicksilver mines at Idra in Friuli, or the Lower Austria, in clay, or in a black stony *lapis ollaris*, out of which it runs, either spontaneously, or by being warmed even in the hands.

- B.* United to gold or silver. *Hydrargyrum argenteum* vel *auro adunatum*.

Mr Kirwan asserts, on the authorities of Monet

and Lin. Von Gmelin, that in Sweden and Germany mercury has been found united to silver in the form of a somewhat hard and brittle amalgam.

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Romé de l'Isle had a specimen of this natural amalgam from Germany, which is imbedded in a quartzose mass, and mixed with cinnabar, as Mr Mongez asserts; and he adds, that in the royal cabinet, at the king's garden at Paris, is deposited another fine specimen of this mercurial ore, which was found crystallised in the mine called *Carolina* at Muehl-lansberg in the duchy of Deux Ponts. M. de l'Isle speaks also very positively of a specimen of native gold from Hungary, which seems to be a natural amalgam of gold and mercury. It is composed of quadrangular prisms, of a greyish yellow colour, and of a brittle texture. This specimen is also in the king's cabinet at the royal garden at Paris.

Mr Kirwan, speaking of the method of examining the purity of gold by the moist way, supposes, with Sir Torbern Bergman, that there are natural amalgamations of mercury with gold and silver: and Neumann observes, that sometimes a mineral, containing gold or silver, is met with among mercurial ores, although this is a great rarity.

It is evident, therefore, that there naturally exist

and at last to a brilliant red: in this state it is called *red precipitate*, or *arcenum corallinum*. It must be made in a matrass with a gentle heat if it is designed to be corrosive for surgical purposes.

(v) 1. The vitriolic acid, concentrated and boiling hot, seizes on mercury, and presently reduces it if urged by heat to a kind of white powder, which turns yellow by the affusion of hot water, but does not dissolve in it; this is called *turbith mineral*: but if cold water, instead of hot, was poured in the white mass, the powder would not change its white colour into yellow as was said above about the nitrous solution.

2. If Mercury be rarefied by heat into vapours, and these meet with those of marine acid in the same state, a corrosive sublimate will be formed. This metallic salt shoots into crystals pointed like daggers, which are the strongest of all poisons. But there are various other processes found in chemical authors to make this salt with more or less trouble. See CHEMISTRY, n° 814—818.

3. If corrosive sublimate be mixed with tin and distilled, a very smoking liquor is produced, called by the name of its inventor the *smoking liquor of Libavius*. See CHEMISTRY, n° 810.

The muriatic acid in the sublimate is not saturated, and from hence proceeds its great corrosive power; for if a fresh quantity of mercury be added to it, and sublimed a second or third time, a sweet, or mixed sublimate, called *mercurius dulcis*, is produced, which is not poisonous, and is given internally as a purgative, or an emetic, according to the dose. See CHEMISTRY, n° 819.

(v) Muriatic acid does not act upon quicksilver unless this last be previously deprived of as much phlogiston, as $\frac{1}{10}$ of the quantity contained in the hundred of silver, or of $\frac{30}{100}$ in the hundred of zinc. (See Bergman's *Sciagraphia*, and his treatise *De Phlogisti quantitate*.)

(w) The academicians of Dijon say, that the true proportion to make this *æthiops*, is that of one part of brimstone with four of mercury. Fourcroy directs only one of mercury, with three of flowers of sulphur, to be triturated, till the mercury is extinguished. A black powder is then produced, which is the *æthiops mineral*. The combination is better effected when the mercury is mixed with the fused sulphur: by agitating this mixture, it becomes black, and easily takes fire; it should be then taken from the fire, and the flame should be extinguished a little after, stirring the mass till it becomes into solid clots. If this substance be exposed to a great degree of heat, it takes fire, the sulphur is consumed, and a substance remains which is of a violet colour when pulverised. This powder being put into matrasses, till their bottom become red by the force of fire, is sublimed after some hours, and artificial cinnabar is found in the top of the vessels crystallised into brown red needles.

Mercury, divided by means of a rapid and continual motion, as that of a mill-wheel, gradually changes itself into a very fine black powder, which is called *æthiops per se*, on account of its colour, in order to distinguish it from this *æthiops mineralis* mentioned in the text.

ist various ores of quicksilver, amalgamated with silver, gold, and other minerals, although they be but seldom met with.

C. Mineralised,

[1.] With sulphur.

a. Pure cinnabar, *Cinnabaris nativa*.

a. Loose or friable cinnabar like red ochre.

b. Indurated or solid cinnabar. It is of a deep red colour; and, with respect to its texture, is either,

1. Steel-grained;
2. Radiated;
3. Composed of small cubes, or scaly; or
4. Crystallised, in a cubical form; it is transparent, and deep red like a ruby.

b. Impure cinnabars.

1.) A mercurial ore is found in Idria, says Gellert, where the mercury lies in an earth or stone, as if it were in a dead form; and has the appearance of a red-brown iron-stone; but it is much heavier than that. It contains from three quarters to seven eighths of the purest mercury; leaves, after distillation, a very black strong earth behind; and gives some marks of cinnabar.

2.) Liver ore, which is most common in Idria, and has its name from its colour.—Outwardly it resembles an indurated iron-clay; but its weight discovers that its contents are metallic. It yields sometimes 80 pounds of quicksilver per hundred weight.

3.) Burning ore; *brand-erz* in German. This ore may be lighted at the candle; and yields from nine to 50 pounds of quicksilver per hundred weight. *Brunnich*.

[2.] With iron by sulphur. Pyritous cinnabar.

Sir Torbern Bergman inserted this ore in the 177th section of his *Sciagraphia*, and seems doubtful whether this be a distinct species from the cinnabar; as the iron is perhaps, says he, only mechanically diffused therein. Mr Mongez remarks, that there are but a few instances of cinnabar in which iron is not found in its calcined form; though, in the act of the ore being reduced, it passes to its metallic state, and becomes capable of being acted on by the loadstone.

Another pyritous ore of cinnabar was found at Menidot, near St Lo in Lower Normandy. It consisted in grains of different sizes, of a red brown colour: they had a vitriolic taste and sulphureous smell. Found also at Almaden in Spain, and at Stahlberg in the Pa-

latinate; though at this last place they are of a dodecaedral form.

[3.] With silver by the aerial acid, and sulphur.

This seems to be a native precipitate *per se*, or calx of mercury. It is said to have been lately found in Idria, in hard compact masses of a brownish-red colour; see *Journal de Physique* for January 1784, p. 61. If this account can be relied upon, it will prove, that quicksilver, even in a calciform state, is naturally found mineralised with silver by means of sulphur.

[4.] With sulphur and copper.

This ore is blackish grey, of a glassy texture, and brittle; crackles and splits excessively in the fire; and when the quicksilver and sulphur are evaporated, the copper is discovered by its common opaque red colour in the glass of borax, which, when farther forced in the fire, or diluted, becomes green and transparent. It is found at Muschlanberg in the duchy of Deux Ponts.

[5.] Mineralised by the marine and vitriolic acids.

Mineralogy owes the discovery of this ore to Mr Woulfe, who published an account of it in the Philosophical Transactions for 1776. It was found in the duchy of Deux Ponts, at the mine distinguished by the name of *Obermofchal*. It had a spar-like appearance. This ore is either bright and white, or yellow or black. It was mixed with cinnabar in a stony matrix; and being well mixed with one-third of its weight of vegetable alkali, afforded cubic and octagonal crystals; that is, salt of Sylvius and vitriolated tartar.

The marine salt of this mercury is in the state of sublimate corrosive.

Order II. IMPERFECT OR BASE METALS.

I. Tin. *Stannum*; *Jupiter*. (See the detached article TIN: Also CHEMISTRY-Index; and METALLURGY, Part II. sect. vi. and Part III. sect. vi.)

This is distinguished from the other metals by the following characters and qualities. It is,

- a. Of a white colour, which verges more to the blue than that of silver.
- b. It is the most fusible of all metals; and,
- c. The least ductile; that is, it cannot be extended or hammered out so much as the others (x).

d. In

(x) Tin is sufficiently ductile to be beaten into very thin leaves. But ductility and extensibility are two different properties, less connected with one another than is generally imagined. Iron and steel are drawn into exquisite fine wire, but cannot be beat into very thin leaves. Tin, on the other hand, is beat into fine leaves, and may be extended between rollers to a considerable surface. The tin-sheet used in various arts, is commonly about $\frac{1}{80}$ th part of an inch; but may be extended twice as much in its dimensions without difficulty. Notwithstanding this extensibility, tin cannot be drawn into wire, on account of the weak cohesion of its particles. A tin wire, however, of one-tenth of an inch diameter, is able to support a weight of 49½ pounds, according to Fourcroy. Gold and silver possess both properties of ductility and extensibility the most eminently of all metallic bodies; whilst lead, notwithstanding its flexibility and softness, cannot be made either into leaves or wire of any fineness.

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- d. In breaking or bending, it makes a crackling noise.
- e. It has a smell particular to itself, and which cannot be described.
- f. In the fire it is easily calcined to white ashes, which are 25 per cent. heavier than the metal itself. During this operation, the phlogiston is seen to burn off in form of small sparks among the ashes or calx.
- g. This calx is very refractory; but may, however, with a very strong degree of heat be brought to a glass of the colour of colophony. But this calx is easily mixed in glass compositions, and makes with them the white enamel.
- h. It unites with all metals and semimetals; but renders most of them very brittle, except lead, bismuth, and zinc.
- i. It amalgamates easily with quicksilver.
- k. It dissolves in aqua-regia, the spirit of sea-salt, and the vitriolic acid; but is only corroded into a white powder by the spirit of nitre. The vegetable acid, soaps, and pure alkaline salts, also corrode this metal by degrees.
- l. Its specific gravity to water is as 7400 to 1000, or as 7321 to 1000.
- m. Dissolved in aqua-regia, which for this purpose ought to consist of equal parts of the spirit of nitre and sea-salt, it heightens the colour of the cochineal, and makes it deeper; for otherwise that dye would be violet.

(1.) Native Tin.

The existence of native tin has long been questioned: but it has undoubtedly been found some years ago in Cornwall, as Mr Kirwan remarks.

- 1. Malleable tin, in a granular form, and also in a foliaceous shape, issuing out of a white hard matter like quartz: but which, after being properly assayed, proved to be arsenical crystals; a circumstance that evinces its being native tin, since the arsenic could not remain in this form if the tin had been melted. It appeared like a thick, jagged, or scolloped lace or edging; and was found near St Austle in Cornwall.
- 2. In the form of crystalline metallic laminæ, or laminated crystals, rising side by side out of an edging, which shone like melted tin: they were almost as thin as flakes or scales of talc, intersecting each other in various directions, with some cavities between them, within which appeared many specks and granules of tin, that could be easily cut with a knife: this was also found in Cornwall.
- 3. In a massy form, more than one inch thick, in some places, and inclosed in a kind of quartzous stone; or rather in an hard crust of crystallised arsenic.

(2.) Calciform Ores of Tin.

A. In form of a calx, *Stannum calciforme*.

1. Indurated, or vitrified.

- 1. Mixed with a small portion of the calx of arsenic.

a. Solid tin ore, without any determinate figure. Tin-stone.

It resembles a garnet of a blackish brown colour, but is much heavier; and has been considered at the English tin-mines as a stone containing no metal, until some years ago it began to be smelted to great advantage.

B. Crystallised.

a. Tin spar, or white tin ore. This is generally of a whitish or grey colour; sometimes it is yellowish, semi-transparent, and crystallised, either of a pyramidal form, or irregularly.

b. Tin-grains. This ore, like the garnets, is of a spherical polygonal figure; but seems more unctuous on its surface.

- 1. In large grains.
- 2. In small grains.

C. Mixed with metals.

- 1. With the calx of iron, as in the garnet.
- 2. With manganese. See the *Semimetals*.

C. Mineralised.

- 1. With sulphur and iron.
- 2. With sulphur. *Aurum musivum*.

This was discovered by Professor Bergman, among some minerals which he received from Siberia. He observed two sorts of it, analogous to the two artificial combinations of tin with sulphur.

- 1. One nearly of the colour of zinc, and of a fibrous texture, which contained about 20 per cent. of sulphur, and the remainder tin.
- 2. The other enveloped the former like a crust; resembled aurum musivum; and contained about 40 per cent. of sulphur, a small proportion of copper, and the remainder tin. *Mem. Stockh. for 1721, p. 328.*

At Huel Rock, in St Agnes in Cornwall, there has been found a metallic vein, nine feet wide, at 20 yards beneath the surface. Mr Raspe was the first who discovered this to be a sulphurated tin-ore: it is very compact, of a bluish white colour, approaching to grey steel, and similar to the colour of grey copper ore: it is lamellar in its texture, and very brittle. It consists of sulphur, tin, copper, and some iron. Mr Raspe proposes to call it *bell-metal ore*.

According to Mr Klaproth's analysis of this ore, 119 grains contain 30 of pure sulphur; 41 of tin; 43 of copper; two of iron; and three grains of the stony matrix. In another specimen of the same sulphurated tin-ore from Cornwall, there were in the hundred 25 parts of sulphur, 34 of tin, 36 of copper, three of iron, and two of the stony matrix.

II. Lead; *Plumbum, Saturnus*. (See the article LEAD, and CHEMISTRY-Index: Also METALLURGY, Part II. sect. v. and Part III. sect. vii.)

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The properties of lead are as follows.

- a. It is of a bluish white colour when fresh broke, but soon dulls or sullies in the air.
- b. It is very heavy; viz. to water as 11,325 to 1000.
- c. It is the softest metal next to gold; but it has no great tenacity, and is not in the least sonorous.
- d. It is easily calcined; and, by a certain art in managing the degrees of the fire, its calx becomes white, yellow, and red.
- e. This calx melts easier than any other metallic calx to a glass, which becomes of a yellow colour, and semitransparent. This glass brings other bodies, and the imperfect metals, into fusion with it.
- f. It dissolves, 1st, In the spirit of nitre; 2dly, In a dilated oil of vitriol, by way of digestion; 3dly, In the vegetable acid; 4thly, In alkaline solutions; and 5thly, In expressed oils, both in the form of metal and of calx.
- g. It gives a sweet taste to all solutions.
- h. It amalgamates with quicksilver.
- i. With the spirit of sea-salt it has the same effect as silver, whereby is produced a *saturnus corneus*.
- k. It does not unite with iron, when it is alone added to it in the fire.
- l. It works on the cupel, which signifies that its glass enters into certain porous bodies, destitute of phlogiston and alkaline salts.
- m. It melts in the fire before it is made red-hot, almost as easily as the tin.
- n. Its calx or glass may be reduced to its metallic state by pot-ashes.

[1.] Native Lead.

For proofs of lead being naturally found in its metallic state, see the article LEAD — It may be here added, that Henckel likewise affirms its existence, in his *Flora Saturnifans*; (see Kirwan's *Elements of Mineralogy*, p. 297, 298.) Wallerius asserts, that it has been so found in Poland, a specimen of which was kept in the collection of Richter; and adds, that a similar one found at Schneeberg, was seen in the collection of Spener. (*Mineralogy*, vol. ii. p. 301.)

Dr Lawson, in his English edition of Cramer's *Art of Essaying Metals*, says, that some pure native malleable lead had been lately found in New England; (p. 147.) And lastly, Professor Bergman did not hesitate to insert, by itself alone, the *plumbum nativum*, in Sect. 180. of his *Sciagraphia*.

[2.] Calciform Lead.

Lead is found,

A. In the form of a calx.

a. Pure.

- a. Friable lead ochre, native ceruse.
- b. Indurated lead spar, or spatose lead ore.
 - i. Radiated, or fibrous.
 1. White, from Mendip-hills, in England.
 - ii. Crystallised in a prismatic figure.
 1. White, from Norrgrufva in Westmanland.

2. Yellowish green, from Zchopau in Saxony.

b. Mixed,

1. With the calx of arsenic, arsenical lead spar.

2. Indurated.

a. White. Mr Cronstedt has tried such an ore from an unknown place in Germany, and found that no metallic lead could be melted from it by means of the blow-pipe, as can be done out of other lead spars; but it must be performed in a crucible. (See the article LEAD, par. iii.)

3. With a calcareous earth.

This ore effervesces with aqua-fortis, and contains 40 per cent. of lead; on which account it is placed here rather than among the calcareous earths.

B. Mineralised.

1. With sulphur alone: the *bley-schwweif*, or *bleyglanz*, of the Germans.

- a. Steel-grained lead-ore.
- b. Radiated, or antimoniated lead-ore.
- c. Tessellated, or potter's lead-ore.

At Villach in Austria there is said to be found a potter's lead-ore, which contains not the least portion of silver.

2. Mineralised by the vitriolic acid.

This ore was discovered by Mr Monnet. It occurs sometimes, though rarely, in the form of a white ponderous calx; and seems to originate from the spontaneous decomposition of the sulphurated lead-ores above mentioned.

3. By the acid of phosphorus.

This ore was lately discovered by Gahn; and is of a greenish colour, by reason of a mixture of iron. See the article LEAD, par. 6.

4. With sulphurated silver. *Galena*; also called *bleyglanz* by the Germans. Potter's ore.

- a. Steel-grained.
- b. With small scales.
- c. Fine-grained.
- d. Of a fine cubical texture; and,
- e. Of coarse cubes. These two varieties are found in all the Swedish silver-mines.
- f. Crystallised.

The steel-grained and scaly ores are of a dim and dull appearance when they are broken, and their particles have no determined angular figure: they are therefore in Swedish commonly called *blyschweif*; in opposition to the cubical ores, which are called *blyglanz*. The most part of the ores called *blyglanz* contain silver, even to 24 ounces per cent. of which we have instances in the mines of Salberg, where it has been observed, that the coarse cubical lead ores are generally the richest in silver, contrary to what is commonly taught in books; the reason of which may perhaps be, that, in making the essays on these two ores, the coarse cubical can be chosen purer or freer

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freer from the rock than the fine cubical ores.

5. With fulphurated iron and silver. This is found,
a. Fine-grained. *b.* Fine cubical. *c.* Coarse-cubical. When this ore is scorified, it yields a black slag; whereas the preceding lead-ores yield a yellow one, because they do not contain any iron.

6. With fulphurated antimony and silver; antimoniated or radiated lead-ore. This has the colour of a blyglanz, but is of a radiated texture.

It is found,

- a.* Of fine rays and fibres; and,
b. Of coarse rays or fibres. The lead in this ore prevents any use being made of the antimony to advantage; and the antimony likewise in a great measure hinders the extracting of the silver.

7. Mineralised by arsenic.

This ore was lately discovered in Siberia.—Externally it is of a pale, and internally of a deep red, colour. See the article LEAD, par. 10.

- C. Mixed with earth; stony, or sandy lead ores.

These consist either of the calciform or of the galena kind, intimately mixed and diffused through stones and earth, chiefly of the calcareous or of the barytic genus. See LEAD, par. 11.

Uses, &c. of Lead. See LEAD, and the other articles above referred to.

- III. Copper; *Cuprum*, *Venus*, *Æs*. (See the article COPPER: Also CHEMISTRY-Index; and METALLURGY, Part II. sect. iv. and Part III. sect. iv.)

This metal is,

- a.* Of a red colour.
b. It is pretty soft and tough.
c. The calx of copper being dissolved by acids becomes green, and by alkalies blue.
d. It is easily calcined in the fire into a blackish blue substance, which, when rubbed to a fine powder, is red; when melted together with glass, it tinges it first reddish brown, and afterwards of a transparent green or sea-green colour.
e. It dissolves in all the acids, and likewise in alkaline solutions. It is easier dissolved when in form of a calx than in a metallic state, especially by the acids of vitriol and sea-salt, and the vegetable acid.
f. Vitriol of copper is of a deep blue colour; but the vegetable acid produces with the copper a green salt, which is verdigris.
g. It can be precipitated out of the solutions in a metallic state; and this is the origin of the precipitated copper of the mines called *Ziment copper*.
h. It is not easily amalgamated with quicksilver; but requires for this purpose a very strong trituration, or the admixture of the acid of nitre.
i. It becomes yellow when mixed with zinc, which

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has a strong attraction to it, and makes brass, Imperfect METALS. pinchbeck, &c. Copper.

- k.* When this metal is exposed to the fire, it gives a green colour to the flame in the moment it begins to melt, and continues to do so afterwards, without losing any thing considerable of its weight.

- [1.] Native copper.

Copper found naturally in a metallic state, is called *virgin* or *native copper*. It is met with,

1. Solid.
 2. Friable, in form of small, and somewhat coherent grains. Precipitated or *ziment copper*.

- [2.] Calciform.

Copper, in form of a calx, is found,

- 1.) Pure.

- a.* Loose or friable; *Ochra veneris*.

1. Blue; *Ceruleum montanum*. Very seldom found perfectly free from a calcareous substance.

2. Green; *Viride montanum*. Both this and the former colour depend on menstrua, which often areedulcorated or washed away.

3. Red. This is an efflorescence of the glass copper ore.

- b.* Indurated. Glass copper-ore.

- a.* Red. This is sometimes as red as sealing wax, and sometimes of a more liver-brown colour.

It is always found along with native copper, and seems to have lost its phlogiston by way of efflorescence, and to be changed into this form. It is likewise found with the fulphurated copper, improperly called *glass copper-ore*.

- 2.) Mixed.

- a.* Loose or friable; *Ochra veneris friabilis impura*.

1. Mixed with a calcareous substance; *Ceruleum montanum*. In this state copper-blue is mostly found. It ferments during the solution in aquafortis.

2. Mixed with iron. Black. It is the decomposition of the Fahlun copper ore.

- b.* Indurated.

1. Mixed with gypsum, or plaster. Green.

2. Mixed with quartz. *a.* Red, from Sunnerskog in the province of Smoland.

3. Mixed with lime. *a.* Blue. This is the *Lapis Armenus*, according to the accounts given of it by authors.

- 3.) Cupreous stones.

Analogous to the calciform copper ores, are,

1. The *lapis armenus*. } See the detached article COPPER, n° 7.
 2. The turquoise. }

- [3.] Dissolved and mineralised; *Cuprum mineralisatum*.

- a.* With sulphur alone. Grey copper-ore; also called, improperly, *glass copper-ore*.

- a.* Solid, without any certain texture, and very soft, so that it can be cut with a knife almost as easily as black lead.

- b.* Fine cubical. In Smoland this is sometimes

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times found decomposed or weathered, and changed into a deep mountain blue.

N. With sulphurated iron. *Minera cupri pyritacea*; yellow copper ore. Marcasitical copper ore; *Pyrites cupri*. This is various both in regard to colour and in regard to the different proportion of each of the contained metals; for instance,

a. Blackish grey, inclining a little to yellow; *Pyrites cupri griseus*. When decayed or weathered, it is of a black colour; is the richest of all the varieties of this kind of copper ore, yielding between 50 and 60 per cent. and is found in Spain and Germany.

b. Reddish yellow, or liver brown, with a blue coat on the surface; *Minera cupri lazurea*. This ore yields between 40 and 50 per cent. of copper, and is commonly said to be blue, though it is as red, when fresh broken, as a red copper regulus.

c. Yellowish green; *Pyrites cupri flavo viridescens*. This is the most common in the north part of Europe: and is, in regard to its texture, found,

1. Solid, and of a shining texture.
2. Steel-grained, of a dim texture.
3. Coarse-grained, of an uneven and shining texture.

4. Crystallised marcasitical copper ore.

a. Of long octoëdric crystals.

d. Pale yellow. This cannot be described but as a marcasite, though an experienced eye will easily discover some difference between them. It yields 22 per cent. of copper.

e. Liver-coloured.

e. With sulphurated silver, arsenic, and some iron. Fallow copper-ore; which contains only a few ounces of silver. This ore is found in Hungary and Germany, where it is called *black copper ore*.

d. With sulphurated arsenic and iron. White copper ore.

e. Pyritous copper, with arsenic and zinc.

According to Mr Monnet, this ore is found at Catharineberg in Bohemia. It is of a brown colour; of a hard, solid, compact, granular texture; and contains from 18 to 30 per cent. of copper.

f. Dissolved by the vitriolic acid; *Vitriolum venenis*. See the article copper, n° xiii.

g. With phlogiston. Copper coal ore, consisting of the calces of copper, mixed with a bituminous earth.

h. Mineralised by the muriatic acid. This ore was found in Saxony, and had been generally mistaken for a micaceous substance, which in fact it greatly resembles. It has not yet been found in large masses, but only in a superficial form, like a crust over other ores. It is moderately hard and friable; of a fine green colour, and sometimes of a bluish green, crystallised in a cubic form, or with a foliated texture, or in little scales resembling green mica or talc. This ore is easily dissolved by

nitrous acid: the solution takes a green colour; and the metal may be precipitated on a polished plate of iron. If some drops of a nitrous solution of silver be mixed with it, a white powder of *luna cornea* will be precipitated, which discovers the presence of the muriatic acid in this ore.

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The uses of copper are very numerous, although not thoroughly known to every one. Several of these have been mentioned under the detached article, and in CHEMISTRY. Others of great importance may be here added. Its great ductility, lightness, strength, and durability, render it of very extensive utility. Blocks, or bars of copper, are reduced into flat sheets of any thickness, by being first heated by the reverberation of the flame, in a low-vaulted furnace, properly constructed for the purpose; and then immediately applied between large rollers of steel, or rather of case-hardened iron, turned by a water-wheel or by the strength of horses, so that the hot metal is there quickly squeezed; and the operation is repeated, bringing the rollers every time nearer to one another, till the metallic sheet acquires the intended thickness.

These copper sheets are very advantageously employed in sheathing the bottoms of men of war and other vessels, which by this means are prevented from being attacked by the sea worms, and are kept clean from various marine concretions, so as to sail with considerably greater swiftness. Copper sheets are also employed to cover the tops of buildings instead of slates or earthen tiles, as is used in Sweden; and some architects have begun to introduce the use of copper covering into Great Britain, which is much lighter, and may be used with great advantage, although it must be much dearer in the prime cost.

Sundry preparations of copper are employed in painting, staining, and for colouring glass and enamels. See GLASS and ENAMEL.

The solution of copper in aqua-fortis stains marble and other stones of a green colour; when precipitated with chalk or whiting, it yields the green and the blue verditer of the painters. According to Lewis, a solution of the same metal in volatile spirits stains ivory and bones: when macerated for some time in the liquor, they become of a fine blue colour, which, however, tarnishes by exposure to the air, and becomes green afterwards.

The same author prepared elegant blue glasses, by melting common glass, or powdered flint and fixed alkaline salt, with blue vitriol, and with an amalgam of copper; fine green ones were made with green verditer, and with blue verditer, as well as with the precipitate of copper made by fixed alkalies, and with a precipitate by zinc; and a reddish glass was produced by the calx and scoria of copper made by fire alone. Even in this vitreous state, it seems as if a continuance of fire had the same effect in regard to colour, as air has upon copper in other forms; as some of the most beautiful blue glasses, by continued fusion, have changed

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changed to a green colour. See farther the article *BRASS in the Glass-trade*.

Verdegris is a preparation of copper dissolved by the vegetable acids, which act on this metal, dissolving it very slowly, but in considerable quantities. It produces a fine green pigment for painting both in oil and water colours, inclining more or less to the bluish according to circumstances.

So great is the tenacity of copper, that a wire of a tenth of an inch in diameter is capable of supporting 299.5 pounds weight before it breaks.—Copper may be drawn into very fine wire, and beaten into extremely thin plates. The German artists, chiefly those of Nuremberg and Augsburg, are said to possess the best method for giving to these thin plates of copper a fine yellow colour like that of gold. See the articles *BRASS-Colour* and *BRASS-Leaf*.

The parings or shreds of these very thin leaves of yellow copper being well ground on a marble plate, are reduced to a powder similar to gold, which serves to cover, by means of some gum-water, or other adhesive fluid, the surface of various mouldings or other pieces of curious workmanship, giving them the appearance of real bronze, and even of fine gold, at a very trifling expence; because the gold colour of this metallic powder may be easily raised and improved by stirring it on a wide earthen basin over a slow fire.

In some of its states, copper is as difficultly extended under the hammer as iron, but proves softer to the file, and never can be made hard enough to strike a spark with flint or other stones; from whence proceeds the use that is made of this metal for chisels, hammers, hoops, &c. in the gun-powder works.

The vitriolic acid does not act on copper unless concentrated and boiling: during this solution a great quantity of sulphureous gas flies off; afterwards a brown thickish matter is found, which contains the calx of the metal partly combined with the acid. By solution and filtration, a blue solution is obtained, which being evaporated to a certain degree, produces after cooling long rhomboidal crystals of a beautiful blue colour, called vitriol of copper; but if this solution be merely exposed a long time to the air, it affords crystals, and a green calx is precipitated, a colour which all calces of this metal assume when dried by the air. Blue vitriol, however, is seldom formed by dissolving the metal directly in the vitriolic acid. That sold in the shops is mostly obtained from copper pyrites. It may also be made by stratifying copper-plates with sulphur, and cementing

them together for some time; because the vitriolic acid of the sulphur being disengaged, attacks and corrodes the metal, forming a metallic salt, which by affusion of water yields perfect crystals of blue vitriol. See *VITRIOL*.

The nitrous acid, on the contrary, dissolves copper when cold with great rapidity; and a great quantity of smoking air or gas flies off, which, on being received in a pneumatic apparatus, and mixed in a glass tube with atmospheric air, shows its good or bad quality for the respiration of living animals, according as the common bulk is more or less diminished. This is one of the most important of Dr Priestley's discoveries; and various instruments known by the name of *eudiometers* have been since invented for making these experiments with ease and satisfaction. See *EUDIOMETER*.

But the most common use of copper is to make all sorts of large stills, boilers, pots, funnels, and other vessels employed by distillers, dyers, chemists, and various other manufacturers, who make use of large quantities of hot liquors in their various operations.

Although copper when pure is extremely valuable, on account of its ductility, lightness, and strength, it is, however, less useful on many occasions from the difficulty of forming large masses of work, as it is not an easy matter to cast copper solid, so as to retain all its properties entire. For if the heat be not sufficiently great, the metal proves deficient in toughness when cold; and if the heat be raised too high, or continued for a length of time, the copper blisters on the surface when cast in the moulds; so that the limits of its fusion are very contracted. And from these circumstances pure copper is rendered less applicable to several purposes.

We find, however, that the addition of a certain proportion of zinc removes almost all these inconveniences, and furnishes a mixed metal more fusible than copper, very ductile and tenacious when cold, which does not so readily scorify in a moderate heat, and which is less apt to rust from the action of air and moisture.

Copper is the basis of fundry compound metals for a great number of mechanical and economical uses of life, such as brass (v), prince's-metal, tombac, bell-metal, white copper, &c. See *CHEMISTRY*, n° 1154, &c.

If the mixture is made of four to six parts of copper, with one part of zinc, it is called *Prince's-metal*. If more of the copper is taken, the mixture will be of a deeper yellow, and then goes by the name of *tombac*.

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Bell-

(v) Brass is frequently made by cementing plates of copper with calamine, where the copper imbibes one-fourth or one-fifth its weight of the zinc which rises from the calamine. The process consists in mixing three parts of calamine and two of copper with charcoal dust in a crucible, which is exposed to a red heat for some hours, and then brought to fusion. The vapours of the calamine penetrate the heated plates of copper, and add thereby to its fusibility. It is of great consequence for the success of this process to have the copper cut into small pieces, and intimately blended with the calamine. See *CHEMISTRY*, n° 1154.

In most foreign founderies the copper is broken small by mechanical means with a great deal of labour; but

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Bell-metal is a mixture of copper and tin, forming a compound extremely hard and sonorous, and is less subject to alterations by exposure to the air than any other cheap metal. On this account it is advantageously employed in the fabrication of various utensils and articles, as cannons, bells, statues, &c. in the composition of which, however, other metals are mixed in various proportions, according to the fancy and experience of the artist. White-copper is prepared with arsenic and nitre, as mentioned under CHEMISTRY, n° 1157. But the principal kind of white-copper is that with which speculums of reflecting telescopes are made. See the article SPECULUM.

VII. Iron; *Ferrum, Mars*. This metal is,

- a. Of a blackish blue shining colour.
- b. It becomes ductile by repeated heating between coals and hammering.
- c. It is attracted by the loadstone, which is an iron ore; and the metal itself may also be rendered magnetical.
- d. Its specific gravity to water is as 7,645, or 8000:1000.
- e. It calcines easily to a black scaly calx, which, when pounded, is of a deep red colour.
- f. When this calx is melted in great quantity with glass compositions, it gives a blackish brown colour to the glass; but in a small quantity a greenish colour, which at last vanishes if forced by a strong degree of heat.

g. It is dissolved by all salts, by water, and like imperfect metals by their vapours. The calx of iron is dissolved by the spirit of sea-salt and by aqua-regia.

h. The calx of the dissolved metal becomes yellow, or yellowish brown: and in a certain degree of heat it turns red.

i. The same calx, when precipitated from acids by means of the fixed alkali, is of a greenish colour; but it becomes blue when precipitated by means of an alkali united with phlogiston; in which last circumstance the phlogiston unites with the iron: these two precipitates lose their colour in the fire, and turn brown.

k. The vitriol of iron is brown. Iron is found,

[1.] Native. See the detached article IRON.

[2.] In form of calx.

A. Pure.

a. Loose and friable. Martial ochre; *Minera ochracea*.

1. Powdery; *Ochra ferri*. This is commonly yellow or red, and is iron which has been dissolved by the vitriolic acid.

2. Concreted. Bog-ore.

a. In form of round porous balls.

b. More solid bars.

c. In small flat pieces, like cakes or pieces of money.

d. In small grains.

e. In

at Bristol the workmen employ an easier method. A pit is dug in the ground of the manufacture about four feet deep, the sides of which are lined with wood. The bottom is made of copper or brass, and is moveable by means of a chain. The top is made also of brass with a space near the centre, perforated with small holes, which are luted with clay; through them the melted copper is poured, which runs in a number of streams into the water, and this is perpetually renewed by a fresh stream that passes through the pit. As the copper falls down it forms itself into grains, which collect at the bottom. But great precaution is required to hinder the dangerous explosions which melted copper produces when thrown into cold water; which end is obtained by pouring small quantities of the metal at once. The granulated copper is completely mixed with powdered calamine, and fused afterwards. The process lasts eight or ten hours, and even some days, according to the quality of the calamine.

It is a wonderful thing, says Cramer, that zinc itself, being simply melted with copper, robs it of all its malleability; but if it be applied in form of vapour from the calamine, the sublimate, or the flowers, it does not cause the metal to become brittle.

The method mentioned by Cramer to make brass from copper, by the volatile emanations of zinc, seems to be preferable to any other process, as the metal is then preserved from the heterogeneous parts contained in the zinc itself, or in its ore. It consists in mixing the calamine and charcoal with moistened clay, and ramming the mixture to the bottom of the melting pot, on which the copper, mixed also with charcoal, is to be placed above the rammed matter. When the proper degree of heat is applied, the metallic vapour of the zinc contained in the calamine will transpire through the clay, and attach itself to the copper, leaving the iron and the lead which were in the calamine retained in the clay, without mixing with the upper metal. Dr Watson says, that a very good metallurgist of Bristol, named John Champion, has obtained a patent for making brass by combining zinc in the vapourous form with heated copper plates; and that the brass from this manufacture is reported to be of the finest kind: but he knows not whether the method there employed is the same with that mentioned by Cramer.

Brass is sometimes made in another way, by mixing the two metals directly; but the heat requisite to melt the copper makes the zinc burn and flame out, by which the copper is defrauded of the due proportion of zinc. If the copper be melted separately, and the melted zinc poured into it, a considerable and dangerous explosion ensues; but if the zinc is only heated and plunged into the copper, it is quickly imbibed and retained. The union, however, of these two metals succeeds better if the flux composed of inflammable substances be first fused in the crucible, and the copper and zinc be poured into it. As soon as they appear thoroughly melted, they are to be well stirred, and expeditiously poured out, or else the zinc will be inflamed, and leave the red copper behind.

Imperfect
METALS.
Iron.

Imperfect
METALS.
Iron.

a. In lumps of an indeterminate figure.
All these are of a blackish brown, or a light brown colour.

B. Indurated. The blood-stone; *Hematites*.

(1.) Of an iron colour; *Hematites caruleus*. This is of a bluish grey colour; it is not attracted by the loadstone, yields a red powder when rubbed, and is hard.

a. Solid, and of a dim appearance when broken.

b. Cubical, and of a shining appearance when broken.

c. Fibrous, is the most common *torrsten* of Sweden.

d. Scaly: the *eisenram* of the Germans.

1. Black.

2. Bluish grey. When this is found along with marcasite, it is not only attracted by the loadstone, but is of itself really a loadstone.

f. Crystallised.

1. In octoedrical crystals.

2. In polyedrical crystals.

3. In a cellular form.

These varieties are the most common in Sweden, and are very seldom blended with marcasite or any other heterogeneous substance except their disseminated beds. It is remarkable, that when these ores are found along with marcasite, those particles which have lain nearest to the marcasite are attracted by the loadstone, although they yield a red or reddish brown powder, like those which are not attracted by the loadstone; it is likewise worth observation, that they generally contain a little sulphur, if they are imbedded in a limestone rock.

(2.) Blackish brown bloodstone; *Hematites nigrescens*. Kidney ore. This yields a red or brown powder when it is rubbed; it is very hard, and is attracted by the loadstone.

a. Solid, with a glassy texture.

b. Radiated.

c. Crystallised.

1. In form of cones, from Siberia.

2. In form of concentric balls, with a faceted surface. These are very common in Germany, but very scarce in Sweden.

(3.) Red bloodstone; *Hematites Ruber*. Red kidney ore.

a. Solid, and dim in its texture.

b. Scaly. The *eisenram* of the Germans. This is commonly found along with the iron-coloured iron glimmer, and smears the hands.

c. Crystallised, in concentric balls, with a flat or faceted surface.

(4.) Yellow bloodstone; *Hematites flavus*.

a. Solid.

b. Fibrous.

The varieties of the colours in the bloodstone are the same with those produced in the

calces of iron made by dry or liquid menstrua and afterwards exposed to different degrees of heat.

B. Mixed with heterogeneous substances.

A. With a calcareous earth. White spathose iron ore. The *Stahlstein* of the Germans.

B. With a siliceous earth. The martial jasper of Sinople.

C. With a garnet earth. Garnet and cockle or shirl.

D. With an argillaceous earth. The bole.

E. With a micaceous earth. Mica.

F. With manganese.

G. With an alkali and phlogiston. Blue martial earth. Native Prussian-like blue.

1. Loose or powdery.

H. With an unknown earth, which hardens in water. Tarras; *Cementum*.

1. Loose or granulated; *Terra Puzzolana*. This is of a reddish brown colour, is rich in iron, and is pretty fusible.

2. Indurated; *Cementum induratum*. This is of a whitish yellow colour, contains likewise a great deal of iron, and has the same quality with the former to harden soon in water when mixed with mortar. This quality cannot be owing to the iron alone, but rather to some particular modification of it occasioned by some accidental causes, because these varieties rarely happen at any other places except where volcanoes have been, or are yet, in the neighbourhood.

[3.] Dissolved or mineralised.

A. With sulphur alone.

A. Perfectly saturated; *Ferrum sulphure saturatum*. Marcasite.

B. With very little sulphur. Black iron ore. Iron stone.

This is either attracted by the loadstone, or is a loadstone itself attracting iron; it resembles iron, and yields a black powder when rubbed.

1.) Magnetic iron ore. The loadstone, *Magnes*.

a. Steel-grained, of a dim texture, from Hogberget in the parish of Gagnef in Dalarna; it is found at that place almost to the day, and is of as great strength as any natural loadstones were ever commonly found.

b. Fine grained, from Saxony.

c. Coarse-grained, from Spitalgruvan at Norberg, and Kierrgruvan, both in the province of Westmanland. This loses very soon its magnetical virtue.

d. With coarse scales, found at Sandfwoer in Norway. This yields a red powder when rubbed.

2.) Refractory iron ore. This in its crude state is attracted by the loadstone.

a. Giving a black powder when rubbed; *Tritura atra*. Of this kind are,

1. Steel-grained.

2. Fine grained.

3. Coarse

Imperfect
METALS.
Iron.

Imperfect
METALS.
Iron.

3. Coarse grained.

This kind is found in great quantities in all the Swedish iron mines, and of this most part of the fusible ores consist, because it is commonly found in such kinds of rocks as are very fusible; and it is as seldom met with in quartz as the hæmatites is met with in limestone.

3. Rubbing into a red powder. These are real hæmatites, that are so far modified by sulphur or lime as to be attracted by the loadstone.

1. Steel-grained.

2. Fine-grained. Emery. This is imported from the Levant: it is mixed with mica, is strongly attracted by the loadstone, and smells of sulphur when put to the fire.

3. Of large shining cubes.

4. Coarse, scaly. The *eisenglimmer* or *eisenran*.

[4.] Mixed with various fossile substances.

1. With sulphur and clay; Pyrites.
2. With arsenic; called *mispickel* by the Germans, and *plate mundic* in Cornwall.
3. With sulphurated arsenic. Arsenical pyrites.
4. With vitriolic acid. Martial vitriol.
5. With phlogiston. Martial coal ore.
6. With other sulphurated and arsenicated metals.

See these in their respective arrangements.

Uses and Properties of Iron. Iron is the most common metal in nature, and at the same time the most useful in common life; notwithstanding which, its qualities are perhaps very little known.

Iron has a particular and very sensible smell when strongly rubbed or heated; and a styptic taste, which it communicates to the water in which it is extinguished after ignition. Its tenacity, ductility, and malleability, are very great. It exceeds every other metal in elasticity and hardness, when properly tempered. An iron wire of one-tenth of an inch thick is able to support 450 pounds weight without breaking, as Wallerius asserts.

Iron drawn into wire as slender as the finest hairs. It is more easily malleable when ignited than when cold; whereas other metals, though ductile when cold, become quite brittle by heat.

It grows red-hot sooner than other metals: nevertheless it melts the most difficultly of all, platina and manganese excepted. It does not tinge the flame of burning matters into bluish or greenish colours, like other imperfect metals, but brightens and whitens it; hence the filings of iron are used in compositions of fire-works, to produce what is called *white-fire*.

Iron, or rather steel, expands the least of all hard metals by the action of heat; but brass expands the most: and on this account these two metals are employed in the construction of compound pendulums for the best sort of regulating clocks for astronomical purposes.

Iron, in the act of fusion, instead of continuing to expand, like the other metals, shrinks, as Dr Lewis observes; and thus becomes so much more

dense as to throw up such part as is unmelted to the surface; whilst pieces of gold, silver, copper, lead, and tin, put in the respective metals in fusion, sink quickly to the bottom. But in its return to a consistent state, instead of shrinking, like other metals, it expands; sensibly rising in the vessel, and assuming a convex surface, whilst the others subside, and appear concave. This property of iron was first taken notice of by Reamur, and excellently fits it for receiving impressions from the moulds into which it is cast, being forced into their minutest cavities. Even when poured thick into the mould, it takes, nevertheless, a perfect impression; and it is observed, that cast iron is somewhat larger than the dimensions of the mould, whilst cast figures of other metals are generally smaller.

The vitriolic acid dissolves iron readily, and forms green vitriol.

This acid requires to be diluted with 304 times its quantity of water, to enable it effectually to dissolve iron; and, during the dissolution, a strong aerial fluid arises, called *inflammable air*, which, on being mixed with atmospheric air, takes fire at the approach of the flame of a candle. A glass phial, of about two ounces measure, with one third of inflammable air, and the rest of common air, produces a very loud report if opened in the same circumstance; and if it be filled with two-thirds of inflammable air, mixed with one of dephlogisticated air, the report will be as loud as the explosion of a pistol with gunpowder.

Dilute nitrous acid dissolves iron; but this saline combination is incapable of crystallising. Strong nitrous acid corrodes and dephlogisticates a considerable quantity of iron, which falls to the bottom.

Marine acid likewise dissolves iron, and this solution is also incrySTALLISABLE.

The Prussian acid precipitates iron from its solutions in the form of Prussian blue.

This metal is likewise sensibly acted upon by alkaline and neutral liquors, and corroded even by those which have no perceptible saline impregnation; the oils themselves, with which iron utensils are usually rubbed to prevent their rusting, often promote this effect in some measure, unless the oils had been previously boiled with litharge or calces of lead.

Galls, and other astringent vegetables, precipitate iron from its solutions, of a deep blue or purple colour, of so intense a shade as to appear black. It is owing to this property of iron that the common writing ink is made. The infusion of galls, and also the Prussian alkali, are tests of the presence of iron by the colours they produce on any fluid. Acids, however, dissolve the coloured precipitates by the former; and hence it arises that the marine acid is successfully applied to take off ink spots and iron stains from white linens. Alkalis, however, convert these iron precipitates into a brown ochre.

Iron has a strong affinity with sulphur. If a bar of iron be strongly ignited, and a roll of brimstone be applied to the heated end, it will combine

SEMI-METALS.
Bismuth.

bine with the iron, and form a fusible mass, which will drop down. A vessel of water ought to be placed beneath for the purpose of receiving and extinguishing it, as the fumes would otherwise be very inconvenient to the operator.

A mixture of iron-filings and sulphur in powder, moistened with water, and pressed so as to form a paste, will in a few hours swell, become hot, fume, and even burst into a flame, if the quantity is large. The residuum furnishes martial vitriol. This process is similar to the decomposition of martial pyrites; from which some philosophers account for hot spring-waters and subterraneous fires. The mixture of water in this paste seems to be necessary to enable the vitriolic acid of the sulphur to act on the iron.

For other chemical properties of this metal, see CHEMISTRY-Index; for its electrical and magnetic properties, see ELECTRICITY and MAGNETISM. For a more particular account of its nature and uses, and the methods of making and manufacturing it, see the articles IRON and STEEL; also METALLURGY, Part II. sect. vii. and Part III. sect. v.

Order III. SEMIMETALS.

I. Bismuth; tin-glass. *Vismutum, Bismutum, Marcasta officinalis.* It is,

- a. Of a whitish yellow colour.
- b. Of a laminated texture, soft under the hammer, and nevertheless very brittle.
- c. It is very fusible; calcines and scorifies like lead, if not rather easier; and therefore it works on the cuppel. It is pretty volatile in the fire.
- d. Its glass or slag becomes yellowish brown, and has the quality of retaining some part of the gold, if that metal has been melted, calcined, and vitrified with it.
- e. It may be mixed with the other metals, except cobalt and zinc, making them white and brittle.
- f. It dissolves in aquafortis, without imparting to it any colour; but to the aqua-regia it gives a red colour, and may be precipitated out of both these solutions with pure water into a white powder, which is called *Spanish white*. It is also precipitated by the acid of sea-salt; which last unites with it, and makes the *vismutum corneum*.
- g. It amalgamates easily with quicksilver. Other metals are so far attenuated by the bismuth, when mixed with it, as to be strained or forced along with the quicksilver through skins or leather.

Bismuth is found in the earth.

A. Native. This resembles a regulus of bismuth, but consists of smaller scales or plates.

1. Superficial, or in crusts.
2. Solid, and composed of small cubes.

B. In form of calx.

1. Powdery or friable; *Ochra vismuti*. This is of a whitish yellow colour; it is found in form of an efflorescence.

It has been customary to give the name of *flowers of bismuth* to the pale red calx of cobalt, but it is wrong; because neither the calx of bismuth, nor its solutions, become red, this being a quality belonging to the cobalt.

C. Mineralised bismuth. This is, with respect to colour and appearance, like the coarse tessellated potter's lead ore; but it consists of very thin square plates or flakes, from which it receives a radiated appearance when broken crosswise.

1. With sulphur.
 - a. With large plates or flakes.
 - b. With fine or small scales.
2. With sulphurated iron.
 - a. Of coarse wedge-like scales.

This mineralised bismuth ore yields a fine radiated regulus; for which reason it has been ranked among the antimonial ores by those who have not taken proper care to melt a pure regulus ore destitute of sulphur from it; while others, who make no difference between regulus and pure metals, have still more positively asserted it to be only an antimonial ore.

3. With sulphur and arsenic.
 - a. Of a whitish yellow or ash colour. It has a shining appearance; and is composed of small scales or plates, intermixed very small yellow flakes; It is of a hard and solid texture: Sometimes strikes fire with hard steel: Has a disagreeable smell when rubbed: Does not effervesce with aqua-fortis; but is partially dissolved by the same acid (z).
 - b. Grey, of a striated form; found at Helsingland in Sweden, and at Annaberg in Saxony.
 - c. With variegated colours of red, blue, and yellow grey; found at Schneeberg in Saxony.
 - d. With green fibres like an amianthus; at Mifnia in Germany, and at Gillebeck in Norway.
 - e. With yellow red shining particles, called *mines de bismuth Tigrees* in French, at Georgenstadt in Germany, and at Annaberg in Saxony.
 - f. The *minera bismuthi arenacea*, mentioned by Wallerius and Bomare, belongs also to the same kind of the arsenicated ores.
4. By vitriolic acid. This ore is called *wismuth blub* by the Germans. It is said to be of a yellowish, reddish, or variegated colour; and to be found mixed with the calx of bismuth, incrusting other ores. *Kirwan*, p. 334.

Uses, &c. of Bismuth. See the article BISMUTH. Also CHEMISTRY-Index; and METALLURGY, Part II. sect. x. and Part III. sect. viii.

SEMI-METALS.
Bismuth.

II.

(z) This solution, being diluted with water, becomes a kind of sympathetic ink; as the words written with it on white paper, and dried, are not distinguished by the eye; but on being heated before the fire, they assume a yellowish colour.

SEMI-METALS.
Zinc.II. Zinc; speltre. *Zincum*.

- a. Its colour comes nearest to that of lead, but it does not so easily tarnish.
- b. It shows a texture when it is broken, as if it were compounded of flat pyramids (A).
- c. Its specific gravity to water is as 6,900 or 7000 to 1000.
- d. It melts in the fire before it has acquired a glowing heat; but when it has gained that degree of heat, it burns with a flame of a changeable colour, between blue and yellow. If in an open fire, the calx rises in form of soft white flowers; but if in a covered vessel, with the addition of some inflammable, it is distilled in a metallic form: in which operation, however, part of it is sometimes found vitrified.
- e. It unites with all the metals (B) except bismuth and nickel, and makes them volatile. It is, however, not easy to unite it with iron without the addition of sulphur. It has the strongest attraction to gold and copper, and this last metal acquires a yellow colour by it; which has occasioned many experiments to be made to produce new metallic compositions.
- f. It is dissolved by all the acids: of these the vitriolic acid has the strongest attraction to it; yet it does not dissolve it, if it is not previously diluted with much water.
- g. Quicksilver amalgamates easier with zinc than with copper; by which means it is separated from compositions made with copper.
- h. It seems to become electrical by friction.

Zinc is found,

A. Native.

Zinc has been met with native, though rarely, in the form of thin and flexible filaments, of a grey colour, which were easily inflamed when applied to a fire. And Bomare affirms that he has seen many small pieces of native zinc among the calamine-mines in the duchy of Limbourg and in the zinc-mines at Gosslar, where this femimetal was always surrounded by a kind of ferruginous yellow earth, or ochraceous substances. See the detached article ZINC.

B. In form of calx.

N° 224.

(1.) Pure.

a. Indurated.

1. Solid
2. Crystallised.

This is of a whitish-grey colour, and its external appearance is like that of a lead spar; it cannot be described, but is easily known by an experienced eye. —It looks very like an artificial glass of zinc; and is found among other calamines at Namur and in England.

(2.) Mixed.

A. With a martial ochre.

1. Half indurated. Calamine; *Lapis calaminaris*.

a. Whitish yellow.

b. Reddish brown. This seems to be a mouldered or weathered blende.

B. With a martial clay or bole.

c. With a lead ochre and iron.

D. With quartz: Zeolite of Friburgh.

The real contents of this substance were first discovered by M. Pelletier. It was long taken for a true zeolite, being of a pearl colour, crystallised, and semitransparent. It consists of laminæ, diverging from different centres, and becoming gelatinous with acids. Its contents are 48 to 52 per cent. of quartz, 36 of calx of zinc, and 8 or 12 of water. (*Kirwan*, p. 318.)

C. Mineralised.

- (1.) With sulphurated iron. Blende, mock-lead, black-jack, mock-ore; *pseudogalena* and blende of the Germans

A. Mineralised zinc in a metallic form. Zinc ore. This is of a metallic bluish-grey colour, neither perfectly clear as a potter's ore, nor so dark as the Swedish iron ores.

1. Of a fine cubical or scaly texture.
2. Steel-grained.

B. In form of calx. Blende. Mock-lead; *Sterile nigrum*. *Pseudo-galena* (c). This is found,

1. With coarse scales.

- a. Yellow; semi-transparent.
- b. Greenish.

c. Greenish.

(A) It cannot be reduced into powder under the hammer like other femimetals. When it is wanted very much divided, it must be granulated, by pouring it while fused into cold water; or filed, which is very tedious, as it stuffs and fills the teeth of the file. But if heated the most possible without fusing it, Macquer asserts, that it becomes so brittle as to be pulverised in a mortar.

(B) It brightens the colour of iron almost into a silver hue; changes that of copper to a yellow or gold colour, but greatly debases the colour of gold and destroys its malleability. It improves the colour and lustre of lead and tin, rendering them firmer, and consequently fitter for sundry mechanic uses. Lead will bear an equal weight of zinc, without losing too much of its malleability.—The process for giving the yellow colour to copper, by the mixture of zinc, and of its ore called *calamine*, has been described above under the *Uses of Copper*.

(C) The varieties of *pseudo-galena*, or black-jack, are in general of a lamellar or scaly texture, and frequently of a quadrangular form, resembling galena. They all lose much of their weight when heated, and burn with a blue flame; but their specific gravity is considerably inferior to that of true galena. Almost all contain a mixture of lead-ore. Most of them exhale a sulphureous smell when scraped; or at least when vitriolic or marine acid is dropped on them.

SEMI-METALS.
Zinc.

c. Greenish-black; *pechblende*, or *pitch blende* of the Germans.

d. Blackish-brown.

2. With fine scales,

a. White.

b. Whitish-yellow.

c. Reddish-brown.

3. Fine and sparkling; at Goslar called *braun blyertz*. Its texture is generally scaly; sometimes crystallised and semitransparent. It gives fire with steel; but does not decrepitate, nor smoke when heated: yet it loses about 13 *per cent.* of its weight by torrefaction.

a. Dark-brown.

b. Red, which becomes phosphorescent when rubbed; found at Scharfenberg in Misnia. (*Brunich*).

c. Greenish, yellowish-green, or red. It has different degrees of transparency, and is sometimes quite opaque. When scraped with a knife in the dark, it emits light, even in water; and after undergoing a white heat, if it is distilled *per se*, a siliceous sublimate rises, which shows it contains the sparry acid, probably united to the metal, since it sublimes.

4. Of a metallic appearance; *glanz blende*.

This is of a bluish-grey, of a scaly or steel grained texture, and its form generally cubical or rhomboidal. It loses nearly one sixth of its weight by calcination; and after calcination it is more soluble in the mineral acids.

100 parts of this ore afforded to Bergman about 52 of zinc, 8 of iron, 4 of copper, 26 of sulphur, 6 of flux, and 4 of water.

5. Crystalline.

a. Dark-red, very scarce; found in a mine near Freyberg. Something like it is found at the Morgenstern and Himmelsfuste.

b. Brown. In Hungary and Transylvania.

c. Black. Hungary.

These varieties may easily be mistaken for rock crystals; but by experience they may be distinguished on account of their lamellated texture and greater softness. Their transparency arises from a very small portion of iron in them.

(2.) Zinc mineralised by the vitriolic acid.

This ore has been already described among the middle Salts, at *Vitriol of zinc*.

Uses, &c. of zinc. See the detached article ZINC: Also CHEMISTRY-Index; and METALLURGY, Part II. sect. xii. and Part III. under sect. iii.

III. Antimony; *Antimonium Stibium*. This semimetal is,

a. Of a white colour almost like silver.

b. Brittle; and, in regard to its texture, it consists

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of shining planes of greater length than breadth.

c. In the fire it is volatile, and volatilises part of the other metals along with it, except gold and platina. It may, however, in a moderate fire, be calcined into a light-grey calx, which is pretty refractory in the fire; but melts at last to a glass of a reddish-brown colour.

d. It dissolves in spirit of sea-salt and aqua regia, but is only corroded by the spirit of nitre into a white calx; it is precipitated out of the aqua regia by water.

e. It has an emetic quality when its calx, glass, or metal, is dissolved in an acid, except when in the spirit of nitre, which has not this effect.

f. It amalgamates with quicksilver, if the regulus, when fused, is put to it; but the quicksilver ought for this purpose to be covered with warm water: it amalgamates with it likewise, if the regulus of antimony be previously melted with an addition of lime.

Antimony is found in the earth.

A. Native. *Regulus antimonii nativus*.

This is of a silver colour, and its texture is composed of pretty large shining planes.

This kind was found in Carls Ort, in the mine of Salberg, about the end of the last century; and specimens thereof have been preserved in collections under the name of an arsenical pyrites, until the mine-master Mr Von Swab discovered its real nature, in a treatise he communicated to the Royal Academy of Sciences at Stockholm in the year 1748. Among other remarkable observations in this treatise, it is said, first, That this native antimony easily amalgamated with quicksilver; doubtless, because it was imbedded in a limestone; since, according to Mr Pott's experiments, an artificial regulus of antimony may, by means of lime, be disposed to an amalgamation: Secondly, That when brought in form of a calx, it shot into crystals during the cooling.

B. Mineralised antimony.

(1.) With sulphur.

This is commonly of a radiated texture, composed of long wedge-like flakes or plates; it is nearly of a lead-colour, and rough to the touch.

a. Of coarse fibres.

b. Of small fibres.

c. Steel-grained, from Saxony and Hungary.

d. Crystallised, from Hungary.

1. Of a prismatical, or of a pointed pyramidal figure, in which last circumstance the points are concentrical.

Cronstedt mentions a specimen of this, in which the crystals were covered with very minute crystals or quartz, except at the extremities, where there was always a little hole: this specimen was given for a *flos ferri spar*.

(2.) With sulphur and arsenic. Red antimony ore; *Antimonium solare*.

This is of a red colour, and has the same texture with the preceding, though its fibres are not so coarse.

R

a. With

- a. With small fibres.
b. With abrupt broken fibres, from Braunsdorf in Saxony, and from Hungary.

All antimonial ores are somewhat arsenical, but this is more so than the preceding kinds.

- (3.) With sulphurated silver. Plumose silver-ore, or *federertz* of the Germans.
(4.) With sulphurated silver, copper, and arsenic; the *dal fahl-ertz* of the Germans.
(5.) With sulphurated lead; radiated lead-ore.
(6.) By the aerial acid.

This ore was lately discovered by Mongez, among those of native antimony from the mine of Chalanges in Dauphiny. It consists of a group of white crystallised filaments of a needle-form appearance, diverging from a common centre, like zeolite. They are insoluble in nitrous acid; and, on being urged by the flame of a blow-pipe, upon a piece of charcoal, they are dissipated into white fumes, or antimonial flowers, without any smell of arsenic; from whence it follows, that these needle-formed crystals are a pure calx of antimony, formed by its combination with, or mineralised by, the aerial acid. See *Kirwan*, p. 325, and *Journal de Physique* for July 1787, p. 67.

Uses, &c. By the name of *antimony* is commonly understood the crude antimony (which is compounded of the metallic part and sulphur) as it melted out of the ore; and by the name of *regulus*, the pure femimetal.

1. Though the regulus of antimony is a metallic substance, of a considerably bright white colour, and has the splendor, opacity, and gravity of a metal, yet it is quite unmalleable, and falls into powder instead of yielding or expanding under the hammer; on which account it is classed among the femimetals.
2. Regulus of antimony is used in various metallic mixtures, as for printing types, metallic speculums, &c. and it enters into the best sort of pewter ware.
3. It mixes with, and dissolves various metals; in particular it affects iron the most powerfully; and, what is very remarkable, when mixed together, the iron is prevented from being attracted by the loadstone.
4. It affects copper next, then tin, lead, and silver; promoting their fusion, and rendering them all brittle and unmalleable: but it will neither unite with gold nor mercury; though it may be made to combine with this last by the interposition of sulphur. In this case it resembles the common *Æthiops*, and is thence called *antimonial Æthiops*.
5. Regulus of antimony readily unites with sulphur, and forms a compound of a very faint metallic splendor: it assumes the form of long needles adhering together laterally: it usually formed naturally also in this shape. This is called *crude antimony*.
6. But though antimony has a considerable affinity to sulphur; yet all the metals, except gold and mercury, have a greater affinity to that com-

pound. If therefore iron, copper, lead, silver, or tin, be melted with antimony, the sulphur will unite with the metal, and be separated from the regulus, which, however, takes up some part of the metal, for which reason it is called *martial regulus*, *regulus veneris*, &c.

7. When gold is mixed, or debased by the mixture of other metals, it may be fused with antimony; for the sulphur combines with the base metals, which, being the lighter, rise up into scoria, while the regulus remains united at the bottom with the gold; which being urged by a stronger degree of heat, is freed from the femimetal, which is very volatile. This method of refining gold is the easiest of all.
8. But the most numerous purposes to which this metal has been applied are those of the chemical and pharmaceutical preparations. Lemery, in his *Treatise on Antimony*, describes no less than 200 processes and formulæ; among which there are many good and many useless ones. The following deserve to be mentioned on account of their utility.
9. Antimony melts as soon as it is moderately red hot, but cannot sustain a violent degree of fire, as it is thereby dissipated into smoke and white vapours, which adhere to such cold bodies as they meet with, and are collected into a kind of farina or powder, called *flowers of antimony*.
10. If it be only moderately heated, in very small pieces, so as not to melt, it becomes calcined into a greyish powder destitute of all splendor, called *calx of antimony*. This calx is capable of enduring the most violent fire; but at last it will run into a glass of a reddish-yellow colour, similar to that of the hyacinth. The infusion made of this coloured antimonial glass, in acidulous wine (such as that of Bourdeaux) for the space of 5 or 6 hours, is a very violent emetic.
11. If equal parts of nitre and regulus of antimony be deflagrated over the fire, the grey calx which remains is called *liver of antimony*.
12. If regulus of antimony be melted with two parts of fixed alkali, a mass of a reddish-yellow colour is produced, which being dissolved in water, and any acid being afterwards added, a precipitate is formed of the same colour, called *golden sulphur of antimony*.
13. Fixed nitre, viz. the alkaline salt that remains after the deflagration of nitre, being boiled with small pieces of regulus of antimony, the solution becomes reddish; and, on cooling, deposits the antimony in the form of a red powder, called *mineral kermes*.
14. Equal parts of the glass, and of the liver of antimony, well pulverised and mixed with an equal quantity of pulverised cream of tartar, being put into as much water as will dissolve the cream of tartar, and boiled for 12 hours, adding now and then some hot water to replace what is evaporated, the whole is to be filtered while hot; then being evaporated to dryness, the saline matter that remains is the emetic tartar.
15. The regulus of antimony being pulverised, and distilled.

distilled with corrosive sublimate of mercury, a thick white matter is produced, which is extremely corrosive, and is called *butter of antimony*. This thick substance may be rendered limpid and fluid by repeated distillations.

16. On mixing the nitrous acid with this butter of antimony, a kind of aqua regia is distilled, called *bezoardic spirit of nitre*.
 17. The white matter that remains from this last distillation may be redistilled with fresh nitrous acid; and the remainder being washed with water, is called *bezoar mineral*, which is neither so volatile nor so caustic as the antimonial butter. This butter being mixed with water, a precipitate falls to the bottom, which is very improperly called *mercurius vitæ*, for it is in fact a very violent emetic.
 18. But if, instead of the regulus, crude antimony be employed, and the same operation be performed, the reguline part separates from the sulphur, unites to the mercury, and produces the substance which is called *cinnabar of antimony*.
 19. Crude antimony being projected in a crucible, in which an equal quantity of nitre is fused, detonates; is calcined, and forms a compound called by the French *fondant de Retrou*, or *antimoine diaphoretique non lavé*. This being dissolved in hot water, falls to the bottom after it is cold; and after decantation is known, when dry, by the name of *diaphoretic antimony*. This preparation excites animal perspiration, and is a good sudorific. The same preparation may be more expeditiously made by one part of antimony with two and a half of nitre, mixed together and deflagrated: the residue of which is the mere calx of antimony, void of all emetic power.
 20. And if the detonation be performed in a tubulated retort, having a large receiver, containing some water adapted to it, both a clyffus of antimony and the antimonial flowers may be obtained at the same time, as Neumann asserts.
 21. When nitre is deflagrated with antimony over the fire, the alkaline basis of the nitre unites with the calx of the semimetal, which may be separated by an acid, and is called *materia perlata*. See farther the article ANTIMONY; also METALLURGY, Part II. sect. ix.
- IV. Arsenic. In its metallic form, is,
- a. Nearly of the same colour as lead, but brittle, and changes sooner its shining colour in the air, first to yellow, and afterwards to black.
 - b. It appears laminated in its fractures, or where broken.
 - c. Is very volatile in the fire, burns with a small flame, and gives a very disagreeable smell like garlic.
 - d. It is, by reason of its volatility, very difficult to be reduced, unless it is mixed with other metals: However, a regulus may be got from the white arsenic, if it is quickly melted with equal parts of pot ashes and soap; but this regulus contains generally some cobalt, most of the white arsenic being produced from the cobalt ores during their calcination. The white arsenic, mix-

ed with a phlogiston, sublimes likewise into octoedral crystals of a metallic appearance, whose specific gravity is 8,308.

- e. The calx of arsenic, which always, on account of its volatility, must be got as a sublimation, is white, and easily melts to a glass, whose specific gravity is 5,000. When sulphur is blended in this calx, it becomes of a yellow, orange, or red colour; and according to the degrees of colour is called *orpiment* or yellow arsenic; *sandarach*, *realgar*, or red arsenic; and also *rubinus arsenici*.
 - f. This calx and glass are dissoluble in water, and in all liquids; though not in all with the same facility. In this circumstance arsenic resembles the salts; for which reason it also might be ranked in that class.
 - g. The regulus of arsenic dissolves in spirit of nitre; but as it is very difficult to have it perfectly free from other metals, it is yet very little examined in various menstrua.
 - h. It is poisonous, especially in form of a pure calx or glass: But probably it is less dangerous when mixed with sulphur, since it is proved by experience, that the men at mineral works are not so much affected by the smoke of this mixture as by the smoke of lead, and that some nations make use of the red arsenic in small doses as a medicine.
 - i. It unites with all metals, and is likewise much used by nature itself to dissolve, or, as we term it, to *mineralise*, the metals, to which its volatility and dissolubility in water must greatly contribute. It is likewise most generally mixed with sulphur.
 - k. It absorbs or expels the phlogiston, which has coloured glasses, if mixed with them in the fire.
- Arsenic is found,
- [1.] Native; called *Scherbencobolt* and *Fliegenstein* by the Germans.
It is of a lead colour when fresh broken, and may be cut with a knife, like black lead, but soon blackens in the air. It burns with a small flame, and goes off in smoke.
A. Solid and testaceous; *Scherbencobolt*.
B. Scaly.
C. Friable and porous; *Fliegenstein*.
(1.) With shining fissures.
This is by some called *Spigel cobalt*.
 - [2.] In form of a calx.
A. Pure, or free from heterogeneous substances.
1. Loose or powdery.
2. Indurated, or hardened. This is found in form of white semi-transparent crystals.
B. Mixed.
A. With sulphur.
1. Hardened.
a. Yellow. Orpiment; *Auripigmentum*.
b. Red. Native realgar, or sandarach.
B. With the calx of tin, in the tin-grains.
c. With sulphur and silver; in the *rothgulden* or red silver ore.
d. With calx of lead, in the lead-spar.
e. With calx of cobalt, in the efflorescence of cobalt.

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Cobalt.

[3.] Mineralised.

A. With sulphur and iron. Arsenical pyrites or marcasite. These kinds in Cornwall are called *silvery* or *white mundics* and *plate mundics*.

This alone produces red arsenic when calcined. It is of a deeper colour than the following.

B. With iron only. This differs with regard to its particles; being,

1. Steel-grained.
2. Coarse-grained.

3. Crystallised.

a. In an octoedral figure. This is the most common kind.

b. Prismatical. The sulphureous marcasite is added to this kind when red arsenic is to be made; but in Sweden it is scarcer than the sulphureous arsenical pyrites.

C. With cobalt, almost in all cobalt ores.

D. With silver.

E. With copper.

F. With antimony.

} See under *Silver*, *Copper*,
and *Antimony*, *supra*.

For the *Uses of Arsenic*, see the detached article ARSENIC, and CHEMISTRY-Index; also METALLURGY, Part II. sect. xiii. and Part III. sect. viii.

V. Cobalt.

This semimetal is,

- a. Of a whitish grey colour, nearly as fine-tempered steel.
- b. Is hard and brittle, and of a fine-grained texture; hence it is of a dusky, or not shining appearance.
- c. Its specific gravity to water is 6000 to 1000.
- d. It is fixed in the fire, and becomes black by calcination: it then gives to glasses a blue colour, inclining a little to violet, which colour, of all others, is the most fixed in fire.
- e. The concentrated oil of vitriol, aquafortis, and aqua-regia, dissolve it; and the solutions become red. The cobalt calx is likewise dissolved by the same menstrua, and also by the volatile alkali and the spirit of sea salt.
- f. When united with the calx of arsenic in a slow (not a brisk) calcining heat, it assumes a red colour: the same colour is naturally produced by way of efflorescence, and is then called the *bloom* or *flowers of cobalt*. When cobalt and arsenic are melted together in an open fire, they produce a blue flame.
- g. It does not amalgamate with quicksilver by any means hitherto known.
- h. Nor does it mix with bismuth, when melted with it, without addition of some medium to promote their union.

[1.] Native cobalt. Cobalt with arsenic and iron in a metallic form.

Pure native cobalt has not yet been found: that which passes for such, according to Kirwan, is mineralised by arsenic. Bergman, however, in his *Sciagraphia*, has entered this present ore under the denomination of *native cobalt*: and certain it is, that among all the cobaltic ores, this

is the nearest to the native state of this semimetal. It always contains a small quantity of iron, besides the arsenic, by which it is mineralised.

This is of a dim colour when broken, and not unlike steel. It is found,

a. Steel-grained, from Loos in the parish of Farila in the province of Helsingeland, and Schneeberg in Saxony.

b. Fine-grained, from Loos.

c. Coarse-grained.

d. Crystallised:

1. In a dendritical or arborescent form;
2. Polyhedral, with shining surfaces;
3. In radiated nodules.

[2.] Calciform cobalt. Cobalt is most commonly found in the earth mixed with iron.

A. In form of a calx.

1.) With iron without arsenic.

a. Loose or friable; cobalt ochre. This is black, and resembles the artificial zaffre.

b. Indurated: *Minera cobalti vitrea*. The schlacken or slag cobalt. This is likewise of a black colour, but of a glassy texture, and seems to have lost that substance which mineralised it, by being decayed or weathered.

2.) With arsenical acid; cobalt-blut, Germ. *Ochra cobalti rubra*; bloom, flowers, or efflorescence of cobalt.

a. Loose or friable. This is often found of a red colour like other earths, spread very thin on the cobalt ores; and is, when of a pale colour, erroneously called *flowers of bismuth*.

b. Indurated. This is commonly crystallised in form of deep red semitransparent rays or radiations: It is found at Schneeberg in Saxony.

B. Mineralised.

1.) With sulphurated iron.

This ore is of a light colour, nearly resembling tin or silver. It is found crystallised in a polygonal form.

a. Of a slaggy texture.

b. Coarse-grained.

This ore is found in Bastnäsgrufva at Raddarshyttan in Westmanland, and discovers not the least mark of arsenic. The coarse-grained becomes slimy in the fire, and sticks to the stirring hook during the calcination in the same manner as many reguli do: It is a kind of regulus prepared by nature. Both these give a beautiful colour.

2.) With sulphur, arsenic, and iron. This resembles the arsenicated cobalt ore, being only rather of a whiter or lighter colour. It is found,

a. Coarse-grained.

b. Crystallised;

1. In a polygonal figure, with shining surfaces, or *glanzkobalt*. It is partly of a white or light colour, and partly of a somewhat reddish yellow.

3.) With

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Cobalt.

SEMI-METALS.
Nickel.

3.) With sulphurated and arsenicated nickel and iron; see *Kupfer-nickel*, below.
Uses, &c. See the article COBALT. See also CHEMISTRY-Index; and METALLURGY, Part II. sect. xi.

VI. Nickel; *Niccolum*. This is the latest discovered semimetal. It was first described by its discoverer Mr Cronstedt, in the Acts of the Royal Academy of Sciences at Stockholm for the years 1751 and 1754, where it is said to have the following qualities:

1. It is of a white colour, which, however, inclines somewhat to red.
2. Of a solid texture, and shining in its fractures.
3. Its specific gravity to water is as 8,500 to 1000.
4. It is pretty fixed in the fire; but, together with the sulphur and arsenic, with which its ore abounds, it is so far volatile as to rise in form of hairs and branches, if in the calcination it is left without being stirred.
5. It calcines to a green calx.
6. The calx is not very fusible, but, however, tinges glass of a transparent reddish-brown or jacinth colour.
7. It dissolves in aquafortis, aqua-regia, and the spirit of sea-salt; but more difficultly in the vitriolic acid, tinging all these solutions of a deep green colour. Its vitriol is of the same colour; but the colcothar of this vitriol, as well as the precipitates from the solutions, become by calcination of a light green colour.
8. These precipitates are dissolved by the spirit of sal ammoniac, and the solution has a blue colour; but being evaporated, and the sediment reduced, there is no copper, but a nickel regulus is produced.
9. It has a strong attraction to sulphur; so that when its calx is mixed with it, and put on a scorifying test under the muffle, it forms with the sulphur a regule: this regule resembles the yellow steel-grained copper-ores, and is hard and shining in its convex surface.
10. It unites with all the metals, except quicksilver and silver. When the nickel regulus is melted with the latter, it only adheres close to it, both the metals lying near one another on the same plane; but they are easily separated with a hammer. Cobalt has the strongest attraction to nickel, after that to iron, and then to arsenic. The two former cannot be separated from one another but by their scorification; which is easily done, since,
11. This semimetal retains its phlogiston a long time in the fire, and its calx is reduced by the help of a very small portion of inflammable matter: it requires, however, a red heat before it can be brought into fusion, and melts a little sooner, or almost as soon, as copper or gold, consequently sooner than iron.

Nickel is found,

A. Native.

This is mentioned by Mr Rinman to have been lately met with in a mine of cobalt in Hesse.

It is very heavy, and of a liver colour, that is, dark red. When pulverised and roasted under a muffle, it forms green excrescences, and smokes; but its smoke has no particular smell: and no sublimate, whether sulphureous or arsenical, can be caught. It is soluble in acids, and the solution is green; but a polished iron plate discovers no copper.

B. In form of a calx. Nickel ochre, aerated nickel.

1. Mixed with the calx of iron. This is green, and is found in form of flowers on kupfer-nickel.

C. Mineralised.

1. With sulphurated and arsenicated iron and cobalt; *Kupfernickel*. This is of a reddish yellow colour; and is found,
 - a. Of a slaggy texture.
 - b. Fine-grained; and
 - c. Scaly. These two are often from their colour confounded with the liver-coloured marcasite.
2. With the acid of vitriol. This is of a beautiful green colour, and may be extracted out of the nickel ochre, or efflorescence of the Kupfernickel.

For a full account of this semimetal, see the article NICKEL, and CHEMISTRY-Index.

VII. Manganese. *Manganesum*.

The ores of this kind are in Swedish called *brunsten*; in Latin *sydæra*, or *magnesia nigra*, in order to distinguish them from the *magnesia alba officinalis*; and in French *manganèse*, &c.

1. Manganese consists of a substance which gives a colour both to glasses and to the solutions of salts, or, which is the same thing, both to dry and to liquid menstrua, viz.
 - a. Borax, which has dissolved manganese in the fire, becomes transparent, of a reddish brown or hyacinth colour.
 - b. The microcosmic salt becomes transparent with it, of a crimson colour, and moulders in the air.
 - c. With the fixed alkali, in compositions of glass, it becomes violet; but if a great quantity of manganese is added, the glass is in thick lumps, and looks black.
 - d. When scorified with lead, the glass obtains a reddish brown colour.
 - e. The lixivium of deflagrated manganese is of a deep red colour.
2. It deflagrates with nitre, which is a proof that it contains some phlogiston.
3. When reckoned to be light, it weighs as much as an iron ore of the same texture.
4. When melted together with vitreous compositions, it ferments during the solution: but it ferments in a still greater degree when it is melted with the microcosmic salt.
5. It does not excite any effervescence with the nitrous acid: aqua-regia, however, extracts the colour out of the black manganese, and dissolves likewise a great portion of it, which by means of an alkali is precipitated to a white powder.

6. Such

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Manganese.

6. Such colours as are communicated to glasses by manganese, are easily destroyed by the calx of arsenic or tin: they also vanish of themselves in the fire.
7. It is commonly of a loose texture, so as to colour the fingers like foot, though it is of a metallic appearance when broken.
- Manganese is found,
- [1.] Native; of the discovery and qualities of which, an account is given under the article MANGANESE in its alphabetical order. See also CHEMISTRY-Index.
- [2.] Calciform.
- A. Loose and friable.
- a. Black; which seems to be weathered or decayed particles of the indurated kind.
- B. Indurated.
- 1.) Pure, in form of balls, whose texture consists of concentric fibres. *Pura spherica radiis concentratis.*
- a. White; very scarce.
- 2.) Mixed with a small quantity of iron.
- a. Black manganese, with a metallic brightness. This is the most common kind, and is employed at the glass-houses and by the potters. It is found,
1. Solid, of a flaggy texture.
 2. Steel-grained.
 3. Radiated.
 4. Crystallised, in form of coherent hemispheres.

VIII. Molybdena.

- A. Lamellar and shining, its colour similar to that of the potter's lead ore.

This substance resembles plumbago or black-lead; and has long been confounded with it, even by Cronstedt. But it possesses very different properties; in particular,

1. Its laminæ are larger, brighter: and, when thin, slightly flexible. They are of an hexagonal figure.
2. It is of a lead colour, and does not strike fire with hard steel.
3. Its specific gravity is = 4,569, according to Kirwan; and 4,7385, according to Briffon.
4. When rubbed on white papper, it leaves traces of a dark brown or bluish colour, as the plumbago or black lead does; but they are rather of an argentine gloss; by which circumstance the molybdena, according to Dr d'Arcet, may be easily distinguished from black-lead, as the traces made by this last are of less brilliant, and of a deeper tinge.
5. In an open fire, it is almost entirely volatile and infusible. Microcosmic salt or borax scarcely affect it; but it is acted upon with much effervescence by mineral alkali, and forms with it a reddish mass, which smells of sulphur.
6. It consists of an acid of peculiar nature (see CHEMISTRY-Index.) united to sulphur. A small proportion of iron is commonly found in it, but this seems merely fortuitous: 100 parts of molybdena contain about 45 of this acid and 55 of sulphur.

7. It is decomposed either by detonation with nitre, or by solution in nitrous acid.
 8. This acid is soluble in 570 times its weight of water in the temperature of 60; the solution reddens that of litmus, precipitates sulphur from the solution of liver of sulphur, &c. The specific gravity of the dry acid is 3,460.
 9. This acid is precipitable from its solution in water by the Prussian alkali, and also by tincture of galls: the precipitate is reddish brown.
 10. If this acid be distilled with three times its weight of sulphur, it reproduces molybdena.
 11. The solution of this acid in water unites to fixed alkalies, and forms crystallisable salts; as it also does with calcareous earth, magnesia, and argil: these last combinations are difficultly soluble. It acts also on the base metals, and with them assumes a bluish colour.
 12. This solution precipitates silver, mercury, or lead, from the nitrous acid, and lead from the marine, but not mercury.
 13. It also precipitates barytes from the nitrous and marine acids, but no other earth. Molybdenous baroselenite is soluble in cold water.
 14. This acid is itself soluble in the vitriolic acid by the assistance of heat; and the solution is blue when cold, though colourless while hot; it is also soluble in the marine acid, but not in the nitrous.
 15. Molybdena tartar and ammoniac precipitate all metals from their solutions by a double affinity. Gold, sublimate corrosive, zinc, and manganese, are precipitated white; iron or tin, from the marine acid, brown; cobalt, red; copper, blue; alum and calcareous earth, white.
 16. This acid has been lately reduced by Mr Hielm; but the properties of the regulus thus obtained are not yet published.
 17. Mr Pelletier obtained also the regulus or molybdena, by mixing its powder with oil into a paste, and exposing it with powdered charcoal in a crucible to a very violent fire for two hours. See CHEMISTRY-Index, n° 14, 97.
 18. This semimetal being urged by a strong fire for an hour, produces a kind of silvery flowers, like those of antimony.
 19. Molybdena is said to be soluble in melted sulphur; which seems highly probable, as sulphur is one of its component parts.
- See farther the article MOLYBDENA, and CHEMISTRY-Index.

IX. Wolfram. *Wolfrum, Spuma Lupi*, Lat. See the detached article WOLFRAM.

This mineral has the appearance of manganese, blended with a small quantity of iron and tin.

1. With coarse fibres.
- a. Of an iron-colour, from Altenberg in Saxony. This gives to the glass compositions, and also to borax and the microcosmic salt, an opaque whitish yellow colour, which at last vanishes.

X. Siderite. } See those words in the order of the
XI. Saturnite. } alphabet.

APPENDIX.

Of Saxa and Petrifications.

THOUGH the *Saxa*, and fossils commonly called *Petrifications*, cannot, in strictness, be ranked in a mineral system, for the reasons formerly given; yet as these bodies, especially the latter, occupy so considerable a place in most mineral collections, and the former must necessarily be taken notice of by the miners in the observations they make in subterranean geography, it appeared proper to subjoin them in such an order as might answer the purpose for which they are regarded by miners and mineralogists.

Order I. SAXA. *Petræ.*

These may be divided into two kinds.

1. Compound *saxa*, are stones whose particles, consisting of different substances, are so exactly fitted and joined together, that no empty space, or even cement, can be perceived between them; which seems to indicate, that some, if not all, of these substances have been soft at the instant of their union.

2. Conglutinated stones, are stones whose particles have been united by some cementitious substance, which, however, is seldom perceivable, and which often has not been sufficient to fill every space between the particles: in this case the particles seem to have been hard, worn off, and in loose, single, unfigured pieces, before they were united.

I. Compound *saxa*.

A. *Ophites*. Scaly limestone with kernels or bits of serpentine stone in it.

1. *Kolmord marble*. It is white and green.
2. *Serpentino antico*, is white, with round pieces of black steatites in it. This must not be confounded with the *serpentino verde antico*.
3. The *Haraldsfo marble*. White, with quadrangular pieces of a black steatites.
4. The *marmor pozzevera di Genova*. Dark green marble, with white veins. This kind receives its fine polish and appearance from the serpentine stone.

B. *Stellten* or *gestelltein*. Granitello.

1. Of distinct particles. In some of these the quartzose particles predominate, and in others the micaceous: in the last case it is commonly slaty, and easy to split.
2. Of particles which are wrapt up in one another.
 - a. Whitish grey.
 - b. Greenish.
 - c. Reddish.

C. *Norrka*. *Murksten* of the Swedes. *Saxum compositum mica, quartzo, et granato.* Appendix. SAXA.

1. With distinct garnets or shirl.
 - a. Light grey.
 - b. Dark grey.
 - c. Dark grey, with prismatical, radiated, or fibrous cockle or shirl.
2. With kernels of garnet-stone.
 - a. Of pale red garnet stone.

The first of this kind, whose slaty strata makes it commonly easy to be split, is employed for mill-stones, which may without difficulty be accomplished, if sand is first ground with them; because the sand wearing away the micaceous particles on the surfaces, and leaving the garnets predominant, renders the stone fitter for grinding the corn.

D. The whetstone, *Cos*. *Saxum compositum mica, quartzo, et forsan argilla martiali in nonnullis speciebus.*

1. Of coarse particles.
 - a. White.
 - b. Light grey.
2. Of fine particles.
 - a. Liver-brown colour.
 - b. Blackish grey.
 - c. Light grey.
 - d. Black. The table-slate, or that kind used for large tables and for school slates.
3. Of very minute and closely combined particles. The Turkey-stone*. This is of an olive colour, and seems to be the finest mixture of the first species of this genus. The best of this sort come from the Levant, and are pretty dear. The whetstone kinds, when they split easily and in thin plates, are very fit to cover houses with, though most of them are without those properties.

F. *Porphyry*; *Porphyrites*. *Italorum porfido*. *Saxum compositum jaspide et felspat, interdum mica et basalte* (p). See the article PORPHYRY.

- a. Its colour is green, with light-green felspat, *Serpentino verde antico*. It is said to have been brought from Egypt to Rome, from which latter place the specimens of it now come.
- b. Deep red, with white felspat.
- c. Black, with white and red felspat.
- d. Reddish brown, with light red and white felspat.
- e. Dark grey, with white grains of felspat also. The dark red porphyry has been most employed for ornaments in building; yet it is not the only one known by the name

(p) Great part of the hill of Bineves in Lochaber is composed of a kind of porphyry. It is remarkably fine, beautiful, and of an elegant reddish colour; "in which (says Mr Williams) the pale rose, the blush, and the yellowish white colours, are finely blended and shaded through the body of the stone; which is of a jelly-like texture, and is undoubtedly one of the finest and most elegant stones in the world. On this hill also is found a kind of porphyry of a greenish colour, with a tinge of brownish red. It is smooth, compact, and heavy; of a close uniform texture, but has no brightness when broken. It has angular specks in it of a white quartz substance."

name of *porfido*, the Italians applying the same name also to the black kind.

- G. The *trapp* of the Swedes. *Saxum compositum jaspide martiali molli, seu argilla martiali indurata*. See the article TRAPP.

This kind of stone sometimes constitutes or forms whole mountains; as, for example, the mountain called *Hunneberg* in the province of Westergotland, and at Drammen in Norway; but it is oftener found in form of veins in mountains of another kind, running commonly in a serpentine manner, contrary or across to the direction of the rock itself. It is not homogeneous, as may be plainly seen at those places where it is not pressed close together; but where it is pressed close, it seems to be perfectly free from heterogeneous substances.—When this kind is very coarse, it is interspersed with felspat; but it is not known if the finer sorts likewise contain any of it. Besides this, there are also some fibrous particles in it, and something that resembles a calcareous spar; this, however, does not ferment with acids, but melts as easy as the stone itself, which becomes a black solid glass in the fire. By calcination it becomes red, and yields in assays 12 or more *per cent.* of iron. No other sort of ore is to be found in it, unless now and then somewhat merely superficial lies in its fissures; for this stone is commonly, even to a great depth in the rock, cracked in acute angles, or in form of large rhomboidal dice. It is employed at the glass-houses, and added to the composition of which bottles are made. In the air it decays a little, leaving a powder of a brown colour; it cracks commonly in the fire, and becomes reddish brown if made red-hot. It is found,

1. Of coarse chaffy particles.
 - a. Dark grey.
 - b. Black.
2. Coarse-grained.
 - a. Dark grey.
 - b. Reddish.

c. Deep brown.

3. Of fine imperceptible particles.

- a. Black. The touchstone; *Lapis lydius*.
- b. Bluish.
- c. Grey.
- d. Reddish.

The black variety (3. a.) is sometimes found so compact and hard, as to take a polish like the black agate: it melts, however, in the fire to a black glass; and is, when calcined, attracted by the load-stone.

- H. *Amygdaloides*. The carpolithi or fruit-stone rocks of the Germans.

It is a martial jasper, in which elliptical kernels of calcareous spar and serpentine stone are included.

- a. Red, with kernels of white limestone, and of a green steatites. This is of a particular appearance, and when calcined is attracted by the loadstone; it decays pretty much in the air, and has some affinity with the trapp, and also with the porphyry. There are sometimes found pieces of native copper in this stone.

- I. The *grönsten* of the Swedes.

Its basis is hornblende, interspersed with mica. It is of a dark green colour, and in Smoland is employed in the iron furnaces as a flux to the bog-ore.

- K. The granite. *Saxum compositum felspata, mica et quartzo, quibus accidentaliter interdum hornblende steatites, granatus et basaltis immixti sunt*. Its principal constituent parts are felspat, or rhombic quartz, mica, and quartz. See the article GRANITE.

It is found,

- (1.) Loose or friable. This is used at the Swedish brass-works to cast the brass in, and comes from France.
- (2.) Hard and compact.
 - a. Red.
 1. Fine-grained;
 2. Coarse-grained.
 - b. Grey, with many and various colours (E).

II. Con-

(E) Mr Wiegleb has analysed a species of green granite found in Saxony. The crystals are heaped together, and form very compact layers; the colour sometimes an olive green, sometimes resembling a pear, and sometimes of a reddish brown; some of them being perfectly transparent, and others nearly so. According to Mr Warren, they contain 25 per cent. of iron; whence they have been called green ore of iron. An ounce of these crystals heated red hot in a crucible lost two grains in weight, and became of the colour of honey. The remainder was put into a retort, and distilled with marine acid, with which it evidently effervesced. The residuum was lixiviated with distilled water, fresh muriatic acid added, and the distillation and lixiviation repeated. The iron precipitated from this lixivium, and reduced partly to its metallic state, weighed two drachms. M. Wiegleb concludes, that the specimen contained two drams $26\frac{1}{2}$ grains of lime. From further experiments he concludes, that 100 parts of the substance contained 36.5 of siliceous earth; lime 30.8; iron 28.7; and water and fixed air 4.0.

Scotland is remarkable for a great number of excellent granites, little or nothing inferior to porphyry. Of these the following kinds are mentioned by Mr Williams.

1. The grey granite, or *moor-stone* as it is called in Cornwall, is very common in this country. In some places it shows no marks of strata; and in others it is disposed in thick unwieldy irregular beds, which are commonly broken transversely into huge masses or blocks of various sizes and shapes. There is a great variety in this kind of stones; some of them differing but little in appearance from basaltis; others are composed of almost equal parts of black and white grains, about the size of small pease, whence it is called *peasy whin* by the

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II. Conglutinated saxa.

Appendix.
SAXA.A. Of larger or broken pieces of stones of the same kinds conglutinated together. *Breccia*.

1. Of limestone cemented by lime.

a. Calcareous breccia; the *marmi brecciat* of the Italians.

When these kinds have fine colours, they

are polished and employed for ornaments in architecture and other æconomical uses.

b. The *lumachella* of the Italians, or shell marbles. These are a compound of shells and corals, which are petrified or changed into lime, and conglutinated with a calcareous substance. When they have many colours, they

the common people. In Galloway and other places it frequently has a longitudinal grain, as if the component parts had been all moved one way by a gentle flow of water. When this kind of granite begins to undergo a spontaneous decomposition by exposure to the atmosphere, we observe that it is composed of pretty large grains of the figures of cubes, rhomboids, &c. some of them so large as to deserve the name of fragments; and the largest of these are always of quartz or feldspath, and talc.

2. Reddish granite, of a gellied texture, which, Mr Williams says, is one of the finest and most elegant stones in the world. The mountains of Bineves, he says, are principally composed of this stone; and it is found in great abundance in many other parts of Scotland, but he never saw it exhibit any marks of stratification.

3. The fine reddish granites, in which several fine shades of colours are blended together, not spread out in tints as in the former. Neither this nor the former are stratified: "On the contrary (says our author), both exhibit such a degree of uniform regularity, that in some places there is no difference between a stone and a mountain, excepting only in magnitude; as many mountains of granite are nothing more than one regularly uniform mass throughout, in which not the least mark of a bed is to be seen, nor hardly a crack or fissure, unless it be at the edge of some precipice or declivity. These two varieties of elegant red granite are met with in the Highlands and Lowlands of Scotland, in Galloway, and many other places. We often find masses of talc so large in this second variety, that some of them may be called fragments, not disposed in any order, but higgledy-piggledy through the body of the stone.

4. Stratified reddish granite, resembling the third in colour and quality, but not always quite so pure or free from admixture of other stony matter of a different quality. This variety frequently contains larger and smaller fragments of fine laminated talc. Mr Williams, however, has seen this kind of granite disposed in pretty regular strata in the shires of Moray and Nairn, and other parts of Scotland.

5. Granite of a white and whitish colour, generally of a granulated texture, containing a great quantity of mica, or small-leaved talc, and the grains of quartz sometimes large and angular. This variety is subject to spontaneous decomposition; part frequently dissolves and falls into lakes, in such an exceedingly fine and attenuated state, that it does not sink in the water. "I have found (says Mr Williams) this substance in many places where water had been accidentally drained off, resembling fine shell marle, only much lighter. When thoroughly dry, it is the lightest fossil substance I ever handled; and, when blanchied with rain, it is as white as snow. This variety of granite is either not stratified, or exhibits thick irregular beds. It frequently contains a considerable quantity of talc, in masses and scales too large to be called mica."

Our author is of opinion, that this fine white substance produced from the decomposition of the granite, is the true kaolin of the Chinese, one of the component parts of porcelain ware. "The authors of the History of China (says he) informs us, that the fine porcelain ware is composed of two different fossil substances, called by them *petuntse* and *kaolin*. We are further told, that the *petuntse* is a fine white vitrescible stone, compact and ponderous, and of considerable brightness in the inside when broken, which they grind to a fine powder; and that the *kaolin* is not a stone, but a fine white earthy substance, not vitrifiable, at least not in the heat of a common potter's furnace: that they mix the *kaolin* and the flour of the *petuntse* together, and form a paste of this mixture, which they mould into all sorts of porcelain vessels. Now, from the best accounts of this matter which I have been able to obtain, after a good deal of search and inquiry, it appears to me, that the sediment which I have mentioned above is the true *kaolin*; and that as the fine white glassy quartz, which is found in irregular masses, and in irregular discontinuous veins or ribs, in some of the rocks of schistus, is the true *petuntse*; and if this observation is really true, it deserves to be remarked, that Scotland is as well furnished with the best materials for making fine porcelain as most countries in the world. The species of quartz which I suppose to be *petuntse* is of a pure fine uniform glassy texture, semitransparent, and of a pure snowy whiteness. A broken piece of this stone, and a newly broken piece of fine porcelain, are very like one another. There is a great quantity of *petuntse*, or pure white quartz, in many places of Scotland, particularly in the north and Highlands. There is a considerable quantity of it upon the shore and washed by the tide between Banff and Cullen, generally in pretty large masses in rocks of bluish schistus; and to the best of my memory it is very fine of the kind. There is also a considerable quantity of it in discontinuous ribs and masses, in rocks of blue schist, about three or four miles north of Callendar in Monteith, upon the side of the high road which runs parallel to Lochleodunich, which I think also very fine. In some places this sort of quartz is tinged with a flesh colour from the neighbourhood of iron, which renders it unfit for porcelain; but there is plenty to be found of a pure white in almost all parts of Scotland, without any mineral tinge whatever. The *kaolin* is perhaps as plentiful in Scotland as the *petuntse*, there being many extensive lakes easily drained, which contain a considerable depth of it; and moreover, it is to be found in many places that have been lakes, which are now laid dry by accident. There is a quantity of *kaolin* about

- they are called *marbles*, and employed for the same purposes as the preceding (F).
2. Of kernels of jasper cemented by a jaspery substance. *Breccia jaspidea*. *Diaspro brecciato* of the Italians.

Of this kind specimens from Italy are seen in collections. A coarse jasper breccia is said to be found not far from Frejus in Provence in France.

3. Of siliceous pebbles, cemented by a jaspery substance,

100 yards below the high road upon the south side of a bridge, about a mile and a half or two miles south of the inn of Aviemore in the Highlands. It lies beneath a stratum of peat bog, in a place which has been a lake, but is now drained by the river Spey cutting through one side of the mound which formed the lake.— There is more than one stratum of the kaolin in this place, and some of it is exceeding white, especially when blanched by the rain: and there is a white granite rock up the rivulet, at some distance above the bridge, the decomposition and dissolution of which is supposed to produce this fine and curious sediment. Several lakes in the Highlands of Scotland are nearly full of kaolin. One of them is situated in the country of Stratherrick in Inverness-shire, less than a mile north of the public road, and upon the west side of the farm of Drimin. It is a pretty long lake, and there is a considerable depth of kaolin in it, which may be drained at a moderate expence; and, if I remember well, the granite rocks which surround it are pretty white and fine. If the kaolin originates from coloured granite, it is good for nothing, especially if it contains the least tinge of iron, because this will discolour and spoil the beauty of the porcelain; but wherever white granite is found composed of quartz, feldspath, and mica, without any admixture of shirl, and especially iron, the kaolin should be diligently sought after in that neighbourhood. Lochdoon, in Galloway, is said to contain a great quantity of kaolin. It was drained some years ago on the supposition of its containing shell marle; but on trying the substance contained in it, it was found not to be marle but kaolin. These substances may easily be mistaken for one another at first; but they are easily distinguished by trying them with acids, the marle readily effervescing with the weakest, and the kaolin not at all with the strongest acid liquors."

6. Grey composite granite is a very beautiful stone, and when broken looks as if composed of small fragments of various sizes and shapes, not unlike calve's-head jelly. When polished, the fragments appear as if set or inlaid in a fine pellucid or water-coloured matter. There is a single stratum of very curious composite granite, a little to the west of Lossiemouth, in the county of Moray, in Scotland of about six or eight feet thick. It is composed chiefly of grains and fragments of various bright and elegant colours, most of which are as large as pease and beans, all fine, hard, and semipellucid; there is about an eighth part of good lead ore in the composition of this stone, of the kind commonly called potter's ore; and it is likewise remarkable, that there is no other granite in that neighbourhood but this single stratum, all the strata above and below it being mostly a coarse, imperfect, grey sand-stone.

7. Granite of a loose friable texture, subject to spontaneous decomposition, and reduction to granite gravel. There is a remarkable rock of this kind near the Queen's-ferry in Scotland, on the road to Edinburgh, which appears in prodigious thick irregular strata. This rock seems to be composed chiefly of quartz, shirl, and some iron; and produces excellent materials for the high roads.

8. In many parts of the north of Scotland, in the Highlands, and in Galloway, there is found an excellent species of grey granite, composed chiefly of red and black coloured grains. This is a fine and very durable stone, very fit for all kinds of architecture.

In speaking of these stones, Mr Williams observes, that the finer and most elegant red granites, and the finest granite-like porphyries, so much resemble one another, that he does not attempt to distinguish them; and Scotland is remarkable for a great number and variety of them. "The elegant reddish granite of Bineves, near Fort William (says he), is perhaps the best and most beautiful in the world; and there is enough of it to serve all the kingdoms on earth, though they were all as fond of granite as ancient Egypt. There are extensive rocks of red granite upon the sea-shore to the west of the ferry of Ballachylish in Appin, and likewise at Strontian, as well as many other parts of Argyleshire. I have seen beautiful red granite by the road side, near Dingwall, and in several other parts of the north of Scotland, which had been blown to pieces with gunpowder, and turned off the fields. There are extensive rocks of reddish granite about Peterhead and Slains, and both of red and grey granite in the neighbourhood of Aberdeen. The hill of Cruffel in Galloway, and several lower hills and extensive rocks in that neighbourhood, are of red and grey granite, where there are great varieties of that stone, and many of them excellent. Upon the sea shore near Kinnedore, west of Lossiemouth, in Moray, there is a bed of stone about eight feet thick, which I think should be called a composite granite. It is composed of large grains, or rather small pieces of bright and beautiful stones of many different colours; and all the stony parts are exceedingly hard, and fit to receive the highest polish. About a sixth or eighth part of it also consists of lead ore, of that species called potter's ore. The separate stony parts composing this stratum are all hard, fine, solid, and capable of the most brilliant polish; and if solid blocks can be raised free from all cracks and blemishes, I imagine, from the beauty and variety of colours of the stony part, and the quantity of bright lead ore which is blended through the composition and body of the stone, that this would be a very curious and beautiful stone when polished."

(F) The stones called *Ludi Helmontii* or *Paracelsi*, have some similarity in their form to the breccia, a. b. for they are composed of various lumps of a marly whitish-brown matter, separated into a great number of polygonous compartments, of various sizes, formed of a whitish-yellow crust of a red calcareous spar, some-

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substance, or something like it. The plumpudding stone of the English; *Breccia filicea*. Its basis, which at the same time is the cement, is yellow; wherein are contained single flinty or agaty pebbles, of a grey colour or variegated. This is of a very elegant appearance when cut and polished: it is found in England and Scotland (6).

4. Of quartzose kernels combined with an unknown cement. *Breccia quartzosa*.
5. Of kernels of several different kinds of stones. *Breccia saxosa*.

a. Of kernels of porphyry, cemented by a porphyry or coarse jaspery substance; *Breccia porphyrea*.

b. Of kernels of several saxa; *Breccia indeterminata*.

c. Of conglutinated kernels of sandstone; *Breccia arenacea*. This kind consists of sandstone kernels, which have been combined a second time together.

The above mentioned brecciae of themselves must demand the distinctions here made between, but which perhaps may seem to be carried too far.

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times pyritous, which often rise a little above the external surface, and inclose each of them on the inside. According to Bomare, the *ludus stellatus belmontii*, found in the county of Kent, is covered with a kind of striated selenite resembling the zeolite. They are for the most part of a globose figure, seldom flat, but often convex on the outside; and sometimes with a concave surface.

According to Wallerius, the *ludus belmontii* loses by calcination about half of its weight; and, on being urged by fire, is melted into a black glassy slag. It effervesces strongly with aqua-fortis, and this solution is of a yellow colour. But what seems very extraordinary, by adding to it some oil of tartar *per deliquium*, bubbles are produced, from which a great number of slender black threads or filaments are produced, sticking like a cobweb to the sides and bottom of the vessel.

These stones are found quite separate by themselves, as well as various stalagmites and crustaceous bodies, on the strata of argillaceous earth, in various parts of Europe, chiefly in Lorrain, Italy, England (in the counties of Middlesex and Kent), and elsewhere.

Wallerius ranges the *ludus belmontii* among the *tophi*, in the Spec. 425. of his System of Mineralogy. Paracelsus had attributed to these stones a lithontriptic power, and Dr Grew says that they are diuretic; but there is not the least proof of their really possessing such qualities.

(g) The breccia stratum, or plumpudding-rock, exhibits a singular appearance as it lies in the ground; being composed of water-rounded stones of all qualities and of all sizes, from small gravel up to large rounded stones of several hundreds weight each; the interstices being filled up with lime and sand. It frequently also contains lime and iron. Sometimes it exhibits a grotesque and formidable appearance; containing many large bullets of various sizes and shapes, without any marks of regular stratification, but looking like one vast mass of bullets of unequal thickness; and in this manner frequently swelled to the size of a considerable mountain. It is frequently cemented very strongly together; so that parts of the hills composed of it will frequently overhang in dreadful precipices, less apt to break off than other rocks in the same situation; one reason for which, besides the strength of the cement, is, that the breccia, when composed of bullets, is less subject to fissures and cutters than other rocks; being frequently found in one solid mass of great extent and thickness. Some of the plumpudding-rocks are made up of smaller parts, coming near to the size of coarse gravel. It is evident, however, that all the parts of the breccia, whether coarse or fine, have been rounded by agitation in water, as the rocks differ nothing in appearance from the coarser and finer gravel found upon the beach of the sea, excepting only that the parts are strongly cemented together in the rocks, and are loose upon the shores of the ocean.

Some of the breccia is composed of finely rounded stones of various and beautiful colours, about the size of plums or nuts, all very hard and fine. Were this species sawed and polished, it would appear as beautiful and elegant as any stone in Europe; much resembling mosaic work in small patterns.

In general, the breccia is regularly stratified or not according to the size of the component parts of the stone. Such rocks as are composed of round gravel and small bullets are generally very regular in their stratification, while those which contain bullets somewhat larger in size are commonly disposed in thick and coarse beds, and such rocks as are made up of the largest kind of bullets seldom show any marks of stratification at all.

Among many other places in Scotland, where breccia or pudding-stone abounds, there are extensive rocks and high cliffs of it upon the south shore at the west end of the Pentland Frith, to the westward of Thurso in Caithness, which stretch quite across the county of Caithness into Sutherland; and in Sutherland as well as Caithness, this rock is of a rough contexture, and appears in pretty high hills, deep glens, overhanging rocks, and frightful precipices, to the west of Brora, Dunrobin, and Dornoch, which gives it a grotesque and formidable appearance in that country. This range of breccia stretches also quite through Sutherland, and likewise through Ross-shire, the west side of Ferndonald, and Dingwall, where it exhibits the very same phenomena as in Sutherland and Caithness. It continues the same longitudinal line of bearing, which is nearly from north-east to south-west, quite through the highland countries of Inverness and Perthshire; and it forms considerable hills, and very high and rugged rocks, upon both sides of that beautiful piece of fresh water Lochness. Much of the stone here, as well as in other places in this range, is composed of large bullets; the rock is very hard and strong, and it hangs in frightful precipices upon both sides of the lake, through which rock Ge-

far, since their particles are so big and plain as to be easily known from one another. These stones are a proof both of the subversions which the mountains in many centuries have undergone, and of some hidden means which nature makes use of in thus cementing different kinds of stones together. Any certain bigness for the kernels or lumps in such compounds, before they deserve the name of *breccia*, cannot be determined, because that depends on a comparison which every one is at liberty to imagine. In some places, the kernels of porphyry have a diameter of six feet, while in others they are no bigger than walnuts. Sometimes they have a progressive size down to that of a fine sandstone. Most of this kind of stone is fit for ornaments, though the workmanship is very difficult and costly.

B. Conglutinated stones of granules or sands of different kinds. Sandstone; *Lapis arenaceus*.

In this division are reckoned those which consist of such minute particles, that all of them cannot easily be discovered by the naked eye. The greatest part, however, consist of quartz and mica; which substances are the most fit to be granulated, without being brought to a powder.

1. Cemented by clay.
 - a. With an apyrous or refractory clay. This is of a loose texture; but hardens, and is very refractory in the fire.
 - b. With common clay.
2. With lime; resembles mortar made with coarse sand.
 - a. Consisting of transparent and greenish grains of quartz and white limestone.
 - b. Of no visible particles. This is of a loose texture, and hardens in the air.
3. With an unknown cement.
 - a. Loose.
 - b. Harder.
 - c. Compact.
 - d. Very hard.
4. Cemented by the rust or ochre of iron. Is found in form of loose stones at several places, and ought perhaps to be reckoned among the *minera arenacea* or sand ores; at least when the martial ochre makes any considerable portion of the whole.
5. Grit-stone. This is of greater or less hardness, mostly of a grey, and sometimes of a yellowish colour; composed of a siliceous and micaceous sand, and rarely of a sparry kind, with greater or lesser particles closely compacted and united by an argillaceous cement. It gives some sparks with steel, is indissoluble for the most

part in acids, and vitrifiable in a strong fire. Appendix. It is used for millstones and whetstones, sometimes for filtering stones and for building. *Fabroni.* SAXA.

N. B. The *argillaceous* grit has been before described, p. 89. col. 1.

6. Elastic. A singular species of sandstone, of which a specimen was shown some years ago to the Royal Academy of Sciences at Paris by the Baron de Dietrich. It is flexible and elastic; and consists of small grains of hard quartz, that strike fire with tempered steel, together with some micaceous mixture. The elasticity seems to depend on the micaceous part, and softness of the natural gluten between both. It is said, that this elastic stone was found in Brazil, and brought to Germany by his excellency the Marquis de Lavradio.

There are also two tables of white marble, kept in the palace Borghese at Rome, which have the same property. But the sparry particles of their substance, though transparent, are rather soft; may be easily separated with the nail, and effervesce with aqua fortis; and there is also in it a little mixture of small particles of talc or mica. See *Journ. de Phys.* for Oct. 1784, p. 275. See also the article MARBLE (*Elastic*.)

C. Stones and ores cemented together; *Minera arenacea*.

1. Of larger fragments.
 - a. Mountain green, or *viride montanum cupri*, and pebbles cemented together, from Siberia.
 - b. Potters lead-ore, with limestone, slate-kernels, and shells.
 - c. Yellow or marcasitical copper ore, with small pebbles.
2. Of smaller pieces.
 - a. Potter's lead-ore with a quartzose sand.
 - b. Mountain green with sand from Siberia.
 - c. Cobalt ore with sand.
 - d. Martial ochre with sand.

Order II. MINERAL CHANGES, OR PETRIFACTIONS.

THESE are mineral bodies in the form of animals or vegetables, and for this reason no others belong to this order than such as have been really changed from the subjects of the other two kingdoms of nature.

I. Earthy changes; *Terra larvata*.

- A. Extraneous bodies changed into a lime substance, or calcareous changes; *Larva calcarea*.
 - (1.) Loose or friable. Chalky changes; *Creta larvata*.

a. In

neral Wade cut a fine military road upon the south side of the lake, at a great expence of time, labour, and gunpowder. These rocks are seen stretching through the mountains of Strathgig into Badenoch, where it forms a remarkable rock and precipice called *Craigdor* or the *Black Rock*. The same range is again seen farther towards the south-west, in several places to the south of the Black Mount, and in the country of Glenorchy in Argyleshire: and Mr Williams supposes, that the longitudinal line of this rock, so far as it has been just pointed out, is little less than 200 miles, and in some places it spreads eight or ten miles in what may be called the latitudinal line across the bearing of the rocks.

- a. In form of vegetables.
b. In form of animals.
1. Calcined or mouldered shells; *Humus conchaceus*.
(2.) Indurated; *Petrificata calcarea*.
a. Changed and filled with solid limestone.
1. In form of animals.
2. In form of vegetables.
b. Changed into a calcareous spar; *Petrificata calcarea spatofo*.
1. In form of animals.
2. In form of vegetables.
- B. Extraneous bodies changed into a stony substance. Siliceous changes; *Larvæ siliceæ*. These are, like the flint,
(1.) Indurated.
a. Changed into flints.
1. Carnelians in form of shells, from the river Tomm in Siberia.
2. Agat in form of wood. Such a piece is said to be in the collection of Count Tessin.
3. Coralloids of white flint, (*Millepora*.)
4. Wood of yellow flint.
- C. Extraneous bodies changed into clay. Argillaceous changes; *Larvæ argillaceæ*.
A. Loose and friable.
1. Of porcelain clay.
a. In form of vegetables.
A piece of white porcelain clay from Japan, with all the marks of the root of a tree, has been observed in a certain collection.
B. Indurated.
1. In an unknown clay.
a. In form of vegetables. *Osteocolla*. It is said to be changed roots of the poplar tree, and not to consist of any calcareous substance.
A sort of fossil ivory is said to be found, which has the properties of a clay; but it is doubtful if it has been rightly examined.
- II. Saline extraneous bodies, or such as are penetrated by mineral salts. *Corpora peregrina insalita. Larvæ insalite*.
A. With the vitriol of iron.
1. Animals.
a. Human bodies have been twice found in the mine at Falun in Dalarne; the last was kept a good many years in a glass-case, but began at last to moulder and fall to pieces.
2. Vegetables.
a. Turf, and
b. Roots of trees.
These are found in water strongly impregnated with vitriol. They do not burn with a flame, but only like coal in a strong fire; neither do they decay in the air.
- III. Extraneous bodies penetrated by mineral inflammable substances, or mineral phlogiston.
A. Penetrated by the substance of pit-coals.
1. Vegetables, which commonly have been woods, or appertaining to them.
a. Fully saturated. *Gagas, Jet*. (See p. 104. Appendix. col. 2.) The jet is of a solid shining texture.
b. Not perfectly saturated; *Mumia vegetabilis*. It is loose; resembles umber, and may be used as such.
- B. Penetrated by rock-oil or asphaltum.
1. Vegetables.
a. Turf.
The Egyptian mummies cannot have any place here, since art alone is the occasion that those human bodies have in length of time been penetrated by the asphaltum, in the same manner as has happened naturally to the wood in pit-coal strata. See MUMMY.
- C. Penetrated by sulphur which has dissolved iron, or by marcasite and pyrites. *Pyrite impregnata. Petrificata pyritacea*.
1. Animals.
a. Human.
b. Bivalves.
c. Univalves.
d. Insects.
- IV. Metals in form of extraneous bodies; *Larvæ metalliferæ*.
A. Silver; *Larvæ argentiferæ*.
(1.) Native.
a. On the surfaces of shells.
(2.) Mineralised with copper and sulphur.
a. Fahlertz, or grey silver ore in form of ears of corn, &c. and supposed to be vegetables, are found in argillaceous slate at Frankenberg and Tahlitteren in Hesse.
- B. Copper; *Larvæ cuprifera*.
(1.) Copper in form of calx.
a. In form of animals, or of parts belonging to them.
1. Ivory and other bones of the elephant.
The Turcois or Turquoise; which is of a bluish green colour, and much valued in the east.
At Simore in Languedoc bones of animals are dug, which during the calcination assume a blue colour; but it is not probable that the blue colour is owing to copper.
(2.) Mineralised copper, which impregnates extraneous bodies; *Cuprum mineralisatum corpora peregrina ingressum*.
a. With sulphur and iron. The yellow or marcasitical copper ore that impregnates,
1. Animals.
a. Shells.
b. In form of fish.
2. With sulphur and silver. Grey silver ore or fahlerts, like ears of corn, from the slate-quarries in Hesse.
- C. Changes into iron; *Larvæ ferriferæ*.
(1.) Iron in form of calx, which has assumed the place or the shape of extraneous bodies; *Ferrum calciforme corpora peregrina ingressum*.
a. Loose; *Larvæ ochraceæ*.
1. Of vegetables.
Roots of trees, from the lake Langelma in Finland. See the acts of the Swedish Academy of Sciences for the year 1742.
b. Indurated.

- b. Indurated; *Larvæ hematitica*.
 1. Of vegetables.
 (2.) Iron mineralised, assuming the shape of extraneous bodies.
 a. Mineralised with sulphur. Marcasite. *Larvæ pyritacea*.
 V. Extraneous bodies decomposing, or in a way of destruction; *Corpora peregrina in gradibus destructionis considerata*. Mould; *Humus*. Turf; *Turba*.
 A. From animals. Animal-mould; *Humus animalis*.
 1. Shells. *Humus conchaceus*.
 2. Mould of other animals; *Humus diversorum animalium*.
 B. Vegetable mould; *Humus vegetabilis*.
 1. Turf; *Turba*.
 a. Solid, and hardening in the air; *Turba solida aere indurescens*. This is the best of the kind to be used for fuel, and comes nearest to the pit-coals. It often contains a little of the vitriolic acid.
 b. Lamellated turf; *Turba foliata*. This is in the first degree of destruction.
 2. Mould of lakes; *Humus lacustris*. This is a black mould which is edulcorated by water.
 3. Black mould; *Humus ater*. This is universally known, and covers the surface of that loose earth in which vegetables thrive best.

Order III. VOLCANIC PRODUCTS (H).

I. SLAGS; *Scoria vulcanorum*.

Slags are found in great abundance in many places of the world, not only where volcanoes yet exist, but likewise where no subterraneous fire is now known: Yet, in Mr Cronstedt's opinion, they cannot be produced but by means of fire. These are not properly to be called *natural*, since they have marks of violence, and of the last change that mineral bodies can suffer without the destruction of the world; nor are they *artificial*, according to the universally received meaning of this word. We cannot, however, avoid giving them a place here, especially after having admitted the petrifications; and shall therefore arrange the principal of them, according to their external marks.

A. Iceland agate; *Achates islandicus niger*.

It is black, solid, and of a glassy texture; but in thin pieces it is greenish and semitransparent like glass-bottles, which contain much iron. The most remarkable circumstance is, that such large solid masses are found of it, that there is no possibility of producing the like in any glass-house.

It is found in Iceland, and in the island of Ascension: The jewellers employ it as an agate, though it is too soft to resist wear.

B. Rhenish millstone; *Lapis molaris Rhenanus*.

Is blackish-grey, porous, and perfectly resembles

a sort of slag produced by mount Vesuvius. A variety of lava, according to Kirwan.
 C. Pumice-stone; *Pumex*.

It is very porous and blistered, in consequence of which it is specifically very light. It resembles that frothy slag which is produced in our iron furnaces.

1. White.

2. Black.

The colour of the first is perhaps faded or bleached, because the second kind comes in that state from the laboratory itself, viz. the volcanoes.

D. Pearl slag; *Scoria constantes globulis vitreis conglomeratis*.

It is compounded of white and greenish glass particles, which seem to have been conglutinated while yet soft or in fusion. Found on the Isle of Ascension.

E. Slag-sand or ashes; *Scoria pulverulenta, cineres vulcanorum*.

This is thrown out from volcanoes in form of larger or smaller grains. It may perhaps be the principle of the Terra Puzzolana; because such an earth is said at this time to cover the ruins of Herculaneum near Naples, which history informs us was destroyed by a volcano during an earthquake.

II. Lavas.

Lava has been generally understood to denote the aggregate mass of melted matters which flow out of the mouths, or burst out from the sides, of burning mountains. According to Mr Kirwan, however, lavas are the immediate produce of liquefaction or vitrification by the volcanic fires, and "should carefully be distinguished from the subsequent productions affected by the water either in a liquid or fluid state, which generally is ejected at the same time." And of lavas, so distinguished, he describes several varieties. See the article LAVA, in the order of the alphabet; where the nature, origin, kinds, and phenomena of lavas, are copiously described and explained.

III. Basaltes.

This sort of stone was by Cronstedt, in the first edition of his Mineralogy, ranked among the garnet earths, and confounded with the shoerls; an impropriety which was pointed out by Bergman in his *Sciagraphia*, sect. 120.—Mr Kirwan considers basaltes as an imperfect lava, and ascribes its origin both to fire and water. He describes it as found, either, 1. In opaque triangular or polyangular columns; which is the proper basaltes: Or, 2. In amorphous masses of different magnitudes; forming solid blocks, from the smallest size to that of whole mountains; which kind is called *trapp*. See the detached article BASALTES (1); where its species and varieties

(H) For the nature, history, theory, &c. of volcanoes, see the article VOLCANO.

(1) In that article, p. 46. col. 1. l. 9. *delete* the words, "The English miners call it *cockle*, the German *schoerl*."—P. 47. col. 2. l. 28. for "a kind of marble," read "a volcanic production." The *Lapis Lydius*, or Touchstone, mentioned in the same paragraph, should have been specified to be of the sort called *Trapp*.

rieties are particularly described, and different opinions stated concerning its formation. See also the article TRAPP.—Some plausible arguments against the volcanic origin of basalt will

be mentioned in the course of the subjoined note (κ), extracted from *Williams's Natural History of the Mineral Kingdom*.

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(κ) There is a great variety of basalt in Scotland, particularly of the grey kinds; some of which are capable of the highest degree of polish. A good black kind is met with on the south side of Arthur's Seat near Edinburgh, where it forms a smooth perpendicular rock, with several of the columns broken off, and the suspended pieces threatening to fall down upon the passengers below. This stone is capable of receiving a fine polish; and, in the opinion of Mr Williams, would be fit for all sorts of ornaments about sepulchral monuments. It will polish to a bright and beautiful black, which will be unfading.

There is another kind, heavy and hard, of a black or blackish-grey colour; of which great quantities have been carried from the Frith of Forth to pave the streets of London. This, for the most part, is coarsely granulated in the inside, though sometimes the grain is pretty fine. Sometimes it is bright in the inside when broken. It is composed of grains of quartz and shirl of different sizes, and commonly contains some iron. It always appears in thick, irregular, beds, some of which are enormously thick; and seldom or ever equally so: on the contrary, where it is found uppermost, it frequently swells into little hills of various sizes. Most of the small islands in the Frith of Forth are composed of this kind of stone; as well as some hills in the neighbourhood of Inverkeithing and of Edinburgh.

The known characteristic of the basalt is to form itself into balls, columns, and other regular figures. The columnar kind assumes a pentagonal, hexagonal, or heptagonal figure; but quadrangular columns are not common. They are all smooth on the outside, and lie parallel and contiguous to one another; sometimes perpendicular, sometimes inclining, in proportion to the position of the stratum which is thus divided: If the stratum lies horizontal, the columns are perpendicular; if inclining, the pillars also incline in exact proportion to the declivity of the strata, being always broken right across the stratum. Some are of one piece from top to bottom; others divided by one or more joints laid upon one another, which form a column of several parts. The rock called the *Giant's Causeway* in Ireland is a pretty good specimen of the jointed columnar basalt: but there is a more beautiful species above Hillhouse lime-quarry, about a mile south of Linlithgow in Scotland; and a coarser one near the toll-bar north side of Queen's Ferry, and several other places in Fife. In some places the basalt is formed into magnificent columns of great length; and in others afford an assemblage of small and beautiful pillars resembling a range of balustrades or organ pipes. Some of the columns on the south side of Arthur's Seat already mentioned are very long; and there are likewise magnificent columns of great length in the island of Egg, and others of the Hebrides. These columns, when broken, are frequently of a black, or blackish grey, in the inside; some of them being composed of small grains, which gives them an uniform and smooth texture; but much of this species of stone has larger grains in its composition, rough, sharp, and unequal, when broken. All the grains, however, are fine, hard, and bright; and the stone in general is capable of a fine polish.

The other species of basalt which forms itself into distinct masses, assumes sometimes a quadrangular, sometimes an oval, globular, or indeterminate figure. They are found of all sizes from the size of an egg to that of an house: but though they differ in shape from the columnar basalt, they agree in almost every other respect; whence Mr Williams thinks that they are only to be accounted a variety of the columnar kind. It is common to see one stratum of the basaltine rocks exhibiting, in one place, regular pillars or globes; and near these, very irregular ones, differing very little from the common cutters found in all rocks; and at no great distance, the same rock is found to run into one entire mass, exhibiting no tendency to be broken or divided into any columns whatever. Of this the rock of Arthur's Seat is an instance. Some of these only produce solid masses of different figures and sizes; while others produce quantities of a softer, friable, stony matter, of the same quality in which the hard masses of different figures are found imbedded. Pretty good specimens of the second kind or variety of basalt are met with on the road-side between Cramond bridge and the Queen's Ferry, and in several other places in the Lothians and in Fife.

The crusted basalt is of two kinds; 1. Such as have the crusts more dry and friable than the internal parts; and, 2. Such as are dry and friable throughout the whole mass.

The first of these has not only a crust of the friable matter adhering to it, but is likewise imbedded in a quantity of the same. Our author has seen many quarries of this kind of basalt dug for the high roads, in which the quantity of soft friable matter greatly exceeded that of the hard masses, and in which incruusted stones of various sizes and shapes appeared. In such quarries, some of the largest masses have only a few coats of penetrable friable matter, surrounding a nucleus which varies in size, but is uniformly hard throughout; and we shall find other yolks in the same quarry imbedded in the softer matter, which, when broken, exhibit a nest of stones including one another like the several coats of an onion. These crusted basalts which envelope one another are a curious species of stone. The several coats of surrounding matter differ nothing in quality from the stones contained in them, and some of the inner crusts are often very hard; but the nucleus within, though small, is always the hardest. The decomposition by the weathering of the softer matter found surrounding and enveloping the harder masses of stone in this and the second species

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cies of basaltine rocks, has produced a phenomenon frequently met with in Great Britain, especially in Scotland, which greatly puzzles many. It is very common in low grounds, and upon some moderate eminences, to see a prodigious multitude of stones of all shapes and sizes, very hard, and pretty smooth on the outside. These stones are sometimes so numerous and large, that it is often found impracticable to clear a field of them. Where those stones are a species of basalt, which they commonly are, and of the second species of basalt described above, they always originate from a decomposition of the more soft or friable parts of those rocks, which moulder or fall away, and leave the harder stones detached and scattered about, and the decomposed matter dissolves by degrees, and becomes good corn mould.

Here Mr Williams takes occasion to contest the opinion of those who think that stones grow or vegetate like plants. He owns indeed that they increase in bulk; but this, he says, is only in such situations as are favourable for an accretion of matter carried down and deposited by the water; in all other situations they grow less and less. "Others (says he) imagine, that these stones (on which this extraneous matter has been deposited) were rolled about; that the asperities and sharp angles were by that means worn off; and that they were all at last deposited as we see them, by the waters of the universal deluge: and, having their obtuse sides and angles, as if they had been rounded by rolling in water, makes these gentlemen confident that they are right; and if we did not frequently find stones exactly of the same figure, size, and quality in the rock, it would be very difficult to overthrow this hypothesis. I have taken great pains to investigate this point, having frequently examined circumstances; and never failed to discover the stratum of rock which those detached stones originally belonged to. "The strata or beds of the several species of basalt spread as wide, and stretch as far, as the other concomitant strata in the neighbourhood where they are found: but they often lie very flat, or with a moderate degree of declivity; and consequently, when the softer and more friable matter found in the interstices of these rocks, which incloses and binds the harder masses in their native beds, is decomposed, the harder stones must then lie scattered wide upon the face of the ground."

The second species of the crusted basalt, viz. that which is dry and friable throughout the whole mass, is generally of a coarse and granulated texture, and of all the various shades of grey colours; from a rusty black to a light-coloured grey. This kind of crusted basalt is developed when the masses are either broken or in a state of decomposition; and there are masses of it of all sizes and shapes found in the rocks, resembling the second and third species of the basalt; appearing alike smooth on the outside, with obtuse angles; in short, resembling the basalt in every respect: but when they are exposed to the external air and weather for any considerable time, the several incrustations decay, decompose, and crumble down by degrees. When they quarry this species of basalt for the roads, they are able to break and pound them small with ease; but the harder species are so hard and cohesive, that they are with the greatest difficulty broken into sufficiently small parts.

Composite basalt resembles the three last species, in figure, colour, and all other external appearances; being distinguishable from them only in the internal structure or grain of the stone. It resembles some of the granites, as consisting of much larger grains than the other basalt. Many of the larger grains in the composite basalt are more than an eighth part of an inch over, and some more than a fourth; appearing with smooth flat surfaces, and of a tabulated texture, exactly resembling the quartz grains so commonly found in the composition of most of the granites. The chief, if not the only, distinguishable difference between the grains in each of them is the colour. They are evidently large grains of quartz, &c. which exhibit flat shining surfaces in both. Those grains or fragments are commonly white, yellowish, red, or black, in the composition of most of the granites; whereas they are often seen of a pale blue, or a bluish grey colour, in the composite basalt, and some of them approaching to white. It is only in the internal structure, however, that these basalt have any resemblance to the granites; in all the external characters, they differ nothing from the rest of their own genus.

A fifth species of basalt is indurated through the whole stratum, solid and uniform through all its parts, and exhibiting only such cracks and fissures or cutters as are commonly met with in other hard beds of stones. Many beds of this species are frequently met with in the coal-fields, and the miners are often obliged to sink through them in their coal-pits. "The Salisbury crags at Edinburgh (says our author) might be singled out as a good example of this species of stone, were it not that part of the same stratum is formed into columns on Arthur's seat; though, I believe, this is no good exception, as it evidently appears that the beds of basalt which are formed into columns, glebes, &c. only assume these figures where they are exposed to the influence of the external air, or have but little cover of rock above them. When any of those beds strike deep under the cover of several other strata, they are not found in columns, &c. Nothing but an uniform mass then appears, although the same bed is regularly formed near the surface; which proves that the columnar and other basalt are formed by shrinking and chapping.

"The strata of basalt spread as wide, and stretch as far in the longitudinal bearing, as the other different strata which accompany them in the countries where they are found. The rocks of basalt also are generally found in very thick strata; and that generally in places where no other rock is found above the basalt, the strata of it are often very unequal in thickness. But this, in general, is only in situations where no other rock is found above it; for when it fairly enters into the surface of the earth, so as to have other regular strata above it, which is seen in an hundred places in the Lothians, Fife, and other parts of Scotland, it then appears pretty equal in thickness, as equal as most other beds of such great thickness are; and yet it is remarkable, that although most of the strata of basalt are of great thickness, there are frequently thin

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strata of various kinds found both above and below it. We have numerous examples of this in all the parts of Scotland where basalt is found; as for instance, there are thin and regular strata seen and quarried both above and below the thick bed of that rock in the Salisbury craigs near Edinburgh. In the Bathgate hills, south of Linlithgow, and in many other parts of Scotland, there are several strata of basalt, and likewise of coal, limestone, freestone, and other concomitants of coal blended promiscuously *stratum super stratum*; and the basalt is frequently found immediately above, and immediately below regular strata of coal; of course basalt is *not the lava of volcanoes*. We can prove to ocular demonstration, from the component parts, and from the situation, stretch, and bearing of the strata of basalt, that they are real beds of stone, coeval with all the other strata which accompany them; and are blended with them in the structure of that part of the globe where they are found, as they dip and stretch as far every way as the other strata found above and below them. If basalt, therefore, be a volcanic production, the other strata must of necessity be so likewise. But how volcanoes should produce coal, and how that coal should come into contact with burning lava, is not a little problematical; or rather it is strangely absurd to imagine that burning lava can come into contact with coal without destroying it.

The regularly stratified quartz white-mountain rock is scarce or rather not to be found in most parts of Britain. In the Highlands, however, it is very common; and in some places of them Mr Williams has seen it stratified as regularly as any of the sand-stones, with other regular strata of different qualities immediately above and below it; and sometimes composing large and high mountains entirely of its own strata. This stone is exceedingly hard, dry, and brittle, full of cracks and sharp angles; the different strata sometimes moderately solid, but often naturally broken into small irregular masses, with angles as sharp as broken glass, and of an uniformly fine and granulated texture, resembling the finest sugar-loaf. There are large and high mountains of this stone in Rosshire and Invernesshire, which, in a clear day, appear at a distance as white as snow, without any sort of vegetation on them except a little dry heath round the edge of the hill.

M I N

Minerva.

MINERVA, or PALLAS, in Pagan worship, the goddess of sciences and of wisdom, sprung completely armed from Jupiter's brain; and on the day of her nativity it rained gold at Rhodes. She disputed with Neptune the honour of giving a name to the city of Athens; when they agreed that whosoever of them should produce what was most useful to mankind, should have that advantage. Neptune, with a stroke of his trident, formed a horse; and Minerva caused an olive to spring from the ground, which was judged to be most useful, from its being the symbol of peace. Minerva changed Arachne into a spider, for pretending to excel her in making tapestry. She fought the giants; favoured Cadmus, Ulysses, and other heroes; and refused to marry Vulcan, choosing rather to live in a state of celibacy. She also deprived Tiresias of sight, turned Medusa's locks into snakes, and performed several other exploits.

Minerva is usually represented by the poets, painters, and sculptors, completely armed, with a composed but agreeable countenance, bearing a golden breast-plate, a spear in her right-hand, and her ægis or shield in the left, on which is represented Medusa's head encircled with snakes, and her helmet was usually entwined with olives.

Minerva had several temples both in Greece and Italy. The usual victim offered her was a white heifer, never yoked. The animals sacred to her were the cock, the owl, and the basilisk.

MINERVÆ *Castrum*, *Arx Minervæ*, *Minervium*, or *Templum Minervæ*, (anc. geogr.), a citadel, temple, and town on the Ionian sea, beyond Hydrus; seen a great way out at sea. Now *Castro*, a town of Otranto in Naples. E. Long. 19. 25. N. Lat. 46. 8.

MINERVÆ *Promontorium* (anc. geogr.), the seat of the Sirens, a promontory in the Sinus Paestanus, the south boundary of Campania on the Tuscan coast; so called from a temple of Minerva on it: situated to the

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M I N

south of Surrentum, and therefore called *Surrentinum*. Now *Capo della Minerva*, on the west coast of Naples, over-against the island Capri.

MINERVALIA, in Roman antiquity, festivals celebrated in honour of Minerva, in the month of March; at which time the scholars had a vacation, and usually made a present to their masters, called from this festival *Minerval*.

MINGRELIA, anciently COLCHIS, a part of Western Georgia, in Asia; bounded on the east by Iberia, or Georgia properly so called; on the west, by the Euxine Sea; on the south, by Armenia, and part of Pontus; and on the north, by Mount Caucasus.

Colchis, or Mingrelia, is watered by a great many rivers; as the Corax, the Hippius, the Cyaneus, the Charistius, the Phasis, where the Argonauts landed, the Absarus, the Cissa, and the Ophis, all emptying themselves into the Euxine Sea. The Phasis does not spring from the mountains in Armenia, near the sources of the Euphrates, the Araxes, and the Tigris, as Strabo, Pliny, Ptolemy, Dionysius, and after them Arrian, Reland, Calmet, and Sanson, have falsely asserted; but rises in Mount Caucasus; and flows not from south to north, but from north to south, as appears from the map of Colchis or Mingrelia in Thevenot's collection, and the account which Sir John Chardin gives of that country. This river forms in its course a small island called also *Phasis*; whence the pheasants, if Isidorus is to be credited, were first brought to Europe, and thence called by the Greeks *Phasiani*. The other rivers of Colchis are considerable.

The whole kingdom of Colchis was in ancient times very pleasant and fruitful, as it is still where duly cultivated; abounded in all the necessities of life; and was enriched with many mines of gold, which gave occasion to the fable of the Golden Fleece and the Argonautic expedition so much celebrated by the ancients.

T

Sir

Mingrelia.

Sir John Chardin tells us, that this country extends above 100 miles in length and 60 in breadth; being not near so extensive as the ancient Colchis, which reached from the frontiers of Iberia or Georgia Proper, westward to the Palus Mæotis: that it is beautifully diversified with hills, mountains, valleys, woods, and plains, but badly cultivated: that there are all the kinds of fruits which are found in England, growing wild, but tasteless and insipid for want of culture: that, if the natives understood the art of making wines, those of this country would be the finest in the world: that there are many rivers which have their source in Mount Caucasus, particularly the Phasis, now called the *Rione*: that the country abounds in bees, hogs, wild boars, stags, and other venison; and in partridges, pheasants, and quails: that falcons, eagles, pelicans, lions, leopards, tigers, wolves, and jackals, breed on Mount Caucasus, and sometimes greatly annoy the country: that the people are generally handsome, the men strong and well made, and the women very beautiful; but both sexes very vicious and debauched: that they marry their nieces, aunts, or other relations, indifferently; and take two or three wives if they please, and as many concubines as they will: that they not only make a common practice of selling their children, but even murder them, or bury them alive, when they find it difficult to bring them up: that the common people use a sort of paste, made of a plant called *gom*, instead of bread; but that of the better sort consists of wheat, barley, or rice: that the gentry have an absolute power over their vassals, which extends to life, liberty, and estate: that their arms are the bow and arrow, the lance, the sabre or broadsword, and the buckler: that they are very nasty; and eat sitting cross-legged upon a carpet, like the Persians; but the poorer sort upon a mat or bench, in the same posture:

that the country is very thin of inhabitants, no less than 12,000 being supposed to be sold yearly to the Turks and Persians: that the principal commodities exported from it are, honey, wax, hides, castor, martin-skins, flax-seed, thread, silk, and linen-cloth; but that there are no gold or silver mines now, and very little money: that the revenue of the prince or viceroy amounts to about 20,000 crowns *per annum*: that the inhabitants call themselves *Christians*; but that both they and their priests are altogether illiterate, and ignorant of the doctrines and precepts of Christianity: that their bishops are rich, have a great number of vassals, and are clothed in scarlet and velvet: and that their service is according to the rites of the Greek church, with a mixture of Judaism and Paganism.

Minho,
Miniature.

The cities of most note in this country in ancient times were Pityus; Dioscurias, or Dioscorias, which was so called from Castor and Pollux, two of the Argonauts, by whom it is supposed to have been founded, and who in Greek are styled *Dioscuroi*, at present known by the name of *Savatapoli*; Aea on the Phasis, supposed to be the same as Hupolis; *Phasis*, so called from the river on which it stood; Cyta, at the mouth of the river Cyaneus, the birth-place of the famous Medea, called from thence, by the poets, *Cytais*; Saracæ, Zadris, Surium, Madia, and Zoliffa. As for modern cities, it does not appear that there are any here considerable enough to merit a description; or, if there are, they seem to be little, if at all, known to Europeans.

MINHO, a great river in Spain, which taking its rise in Galicia, divides that province from Portugal, and falls into the Atlantic at Caminha.

MINIATURE, in a general sense, signifies representation in a small compass, or less than the reality.

MINIATURE-PAINTING;

A DELICATE kind of painting, consisting of little points or dots; usually done on vellum, ivory, or paper, with very thin, simple water-colours.—The word comes from the Latin *minium*, “red-lead;” that being a colour much used in this kind of painting. The French frequently call it *mignature*, from *mignon*, “fine, pretty,” on account of its smallness and delicacy: and it may be ultimately derived from *μικρος* “small.”

Miniature is distinguished from other kinds of painting by the smallness and delicacy of its figures and faintness of the colouring; on which account it requires to be viewed very near.

SECT. I. Of Drawing and Designing.

To succeed in this art, a man should be perfectly skilled in the art of designing or drawing; but as most people who affect the one, know little or nothing of the other, and would have the pleasure of painting without giving themselves the trouble of learning to design (which is indeed an art that is not acquired without a great deal of time, and continual application), inventions have been found out to supply the

place of it; by means of which a man designs or draws, without knowing how to design.

The first is chalking: that is, if you have a mind to do a print or design in miniature, the backside of it, on another paper, must be blackened with small-coal, and then rubbed very hard with the finger wrapped in a linen cloth: afterwards the cloth must be lightly drawn over the side so blackened that no black grains may remain upon it to soil the vellum you would paint upon; and the print or draught must be fastened upon the vellum with four pins, to keep it from shifting. And if it be another paper that is blackened, it must be put between the vellum and the print, or draught, with the blackened side upon the vellum. Then, with a blunted pin or needle, you must pass over the principal lines or strokes of the print, or draught, the contours, the plaits of the drapery, and over every thing else that must be distinguished; pressing so hard, that the strokes may be fairly marked upon the vellum underneath.

Copying by squares is another convenient method for such as are but little skilled in the art of designing, and would copy pictures, or other things, that cannot be chalked. The method is this: The piece must be divided

S U P P L E M E N T

TO THE THIRD EDITION OF THE

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OR, A

D I C T I O N A R Y

OF

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AND

MISCELLANEOUS LITERATURE.

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Illustrated with Fifty Copperplates.

By GEORGE GLEIG, LL.D. F.R.S. EDIN.

NON IGNORO, QUÆ BONA SINT, FIERI MELIORA POSSE DOCTRINA, ET QUÆ NON OPTIMA,
ALIQUO MODO ACUI TAMEN, ET CORRIGI POSSE.—*CICERO.*

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Meninski,
Merchetta.

words are added, from Wankuli and Ferhengi, the best Arabic and Persic lexicographers whom the East has produced; and from Herbelot are inserted the names of kingdoms, cities, and rivers, as well as phrases in common use among the Turks, &c. *Diminished*, because many useless synonyma are omitted, which rather puzzled than assisted the student; as well as all the French, Polish, and German interpretations, the Latin being considered as sufficient for all men of learning. *Amended*, with respect to innumerable typographical errors; which, however, from a work of this nature, no care can perhaps altogether exclude. The other works of Meninski were occasioned chiefly by a violent contest between him and a man named J. B. Podesta, in which much acrimony was employed on both sides. These it is hardly worth while to enumerate, but they may all be seen in the account of his life from which this article is taken (A). It should be observed, however, that in 1674, Podesta published a book, intitled, "Prodromus novi linguarum orientalium collegii, jussu Aug. &c. erigendi, in Univ. Viennensi;" to which Meninski opposed, 2. "Meninskii Antidotum in Prodromum novi ling. orient. collegii, &c." 4to. But such was the credit of his antagonist in the university, that soon after there came out a decree in the name of the rector and consistory, in which that antidote of Meninski's is proscribed and prohibited, for six specific reasons, as impious and infamous. Meninski was defended against this formidable attack by a friend, in a small tract, intitled, "Veritas defensa, seu justitia causæ Dn. F. de M. M. [Meninski] contra infame decretum Universitatis Viennensis, Anno 1674, 23 Novembris, &c. ab Amico luci exposita, Anno 1675," in which this friend exposes, article by article, the falsehood of the decree, and exclaims strongly against the arts of Podesta. This tract is in the British Museum. Podesta was oriental secretary to the emperor, and professor of those languages at Vienna; but is described in a very satirical manner by the defender of Meninski. "Podesta, natura Semi-Italus, statura nanus, cæcutiens, balbus, imo bardus repertus, aliisque vitiis ac stultitiis plenus, adeoque ad discendas linguas orientales inhabilis." A list of the works of Podesta is, however, given by the late editors of Meninski.

MERCHETTA, or *MARCHETTA Mulierum*, is commonly supposed to have been a right which, during the prevalence of the feudal system, the lord had of passing the first night after marriage with his female villain. This opinion has been held by the greater part of our antiquarians; and we have adopted it in our history of SCOTLAND published in the *Encyclopædia*. It appears, however, to be a mistake. That there was a custom called *merchetta mulierum*, which prevailed not only in England, Scotland, Wales, and the isle of Guernsey, but also on the continent, is indeed a fact unquestionable; but Mr Asple has clearly proved, that, instead of being an adulterous connection, the *merchetta* was a compact between the lord and his vassal for the redemption of an offence committed by that vassal's unmarried daughter. He admits, however, that it denoted likewise a

fine paid by a *sokeman* or a *villain* to his lord for a licence to marry his daughter to a free man; and that if the vassal gave her away without obtaining such a licence, he was liable to pay a heavier fine. He quotes two authorities in support of his opinion from Bracton; one of which we shall transcribe, as being alone complete evidence.

"Ric. Burre tenet unum mesuagium et debet telligium sectam curiæ, et *merchet*, hoc modo, quod si maritare voluerit filiam suam cum quodam libero homine, extra villam, faciet pacem domini pro maritagio, et si eam maritaverit alicui custumario villæ, nihil debuit pro maritagio."

"The probable reason of the custom (says Mr Asple) appears to have been this. Persons of low rank, residing on an estate, were either *ascripti glebæ*, or were subjected to some species of servitude similar to the *ascripti glebæ*. They were bound to reside on the estate, and to perform several services to the lord. As women necessarily followed the residence of their husbands, the consequence was, that when a woman of low rank married a stranger, the lord was deprived of part of his live stock; he therefore required a fine to indemnify him for the loss of his property." Further particulars on the *merchetta* are to be found in the Appendix to vol. 1st of *Sir David Dalrymple's Annals of Scotland*.

MERIDIAN LINE, an arch or part of the meridian of the place, terminated each way by the horizon. Or, a meridian line is the intersection of the plane of the meridian of the place with the plane of the horizon, often called a north and south line, because its direction is from north to south.

In the article ASTRONOMY (*Encycl.*), n° 376. and 377. we have given two methods of drawing a meridian line; but it may be proper to add, in this place, the following improvement of the former of these from Dr Hutton's Mathematical Dictionary. "As it is not easy (says the Doctor) to determine precisely the extremity of the shadow, it will be best to make the stile flat at the top, and to drill a small hole through it, noting the lucid point projected by it on the several concentric circles, instead of marking the extremity of the shadow itself on these circles."

We shall give another method of drawing a meridian line from the same valuable dictionary.

"Knowing the south quarter pretty nearly, observe the altitude FE of some stars on the east side of it, and not far from the meridian HZRN: then, keeping the quadrant firm on its axis, so as the plummet may still cut the same degree, direct it to the western side of the meridian, and wait till you find the star has the same altitude as before, as *fe*. Lastly, bisect the angle ECE, formed by the intersection of the two planes in which the quadrant has been placed at the time of the two observations, by the right line HR, which will be the meridian sought."

Magnetical MERIDIAN, is a great circle passing thro' or by the magnetical poles; to which meridians the magnetical needle conforms itself. See MAGNETISM, *Suppl.*

MESO.

(A) We have taken this article from the Biographical Dictionary; the editors of which took it from the life of Meninski prefixed to the new edition of his great work.

Meso-
Logarithm
||
Mills.

MESO-LOGARITHM, a term used by Kepler to signify the logarithms of the cosines and cotangents.

MESURATA, a sea port of the kingdom of Tripoli, in Africa. A caravan proceeds from this place to Fezzan, and other interior parts toward the south of Africa. It is 260 miles north of Mourzook. E. Lon. 15. 5. N. Lat. 31. 3.

METALLIC TRACTORS. See PERKINISM in this Suppl.

METONIC CYCLE, called also the *Golden Number*, and *Lunar Cycle*, or *Cycle of the Moon*, that which was invented by Meton the Athenian; being a period of 19 years. See CYCLE, *Encycl.*

MHA RAJAH, the highest title of Hindoos.

MICROCOUSTICS, or MICROPHANES, instruments contrived to magnify small sounds, as microscopes do small objects.

MICROCOSMIC SALT. See CHEMISTRY-Index, Suppl.

MIDDLE LATITUDE, is half the sum of two given latitudes; or the arithmetical mean, or the middle between two parallels of latitude. Therefore,

If the latitudes be of the same name, either both north or both south, add the one number to the other, and divide the sum by 2; the quotient is the middle latitude, which is of the same name with the two given latitudes. But,

If the latitudes be of different names, the one north and the other south; subtract the less from the greater, and divide the remainder by 2, so shall the quotient be the middle latitude, of the same name with the greater of the two.

MIDSUMMER-DAY, is held on the 24th of June, the same day as the nativity of St John the Baptist is held.

MILK, or MILKYET, property in Bengal.

MILLS of various kinds are described in the article MECHANICS (*Encycl.*); and he who shall study that article, together with *Water-Works*, and MACHINERY, in this Supplement, will have a sufficient knowledge of the principles upon which mills must be constructed, so as that they may produce their proper effects. The subject is introduced into this place merely to put it into the power of our countrymen to adopt, if they shall

think fit, the improvements which have been made in the machinery of flour mills in America.

The chief of these consist in a new application of the screw, and the introduction of what are called elevators, the idea of which was evidently borrowed from the chain-pump. The screw is made by sticking small thin pieces of board, about three inches long and two wide, into a cylinder, so as to form the spiral line. This screw is placed in a horizontal position, and by turning on its axis it forces wheat or flour from one end of a trough to the other. For instance, in the trough which receives the meal immediately coming from the stones, a screw of this kind is placed, by which the meal is forced on, to the distance of six or eight feet, perhaps, into a reservoir; from thence, without any manual labour, it is conveyed to the very top of the mill by the elevators, which consist of a number of small buckets of the size of tea cups, attached to a long band that goes round a wheel at the top, and another at the bottom of the mill. As the band revolves round the wheels, these buckets dip into the reservoir of wheat or flour below, and take their loads up to the top, where they empty themselves as they turn round the upper wheel. The elevators are inclosed in square wooden tubes, to prevent them from catching in any thing, and also to prevent dust. By means of these two simple contrivances, no manual labour is required from the moment the wheat is taken to the mill till it is converted into flour, and ready to be packed, during the various processes of screening, grinding, sifting, &c.

That this is a considerable improvement is obvious; and we are not without hopes that it may be adopted. The licentiousness of an English mob has indeed persecuted an Arkwright, expelled the inventor of the fly-shuttle from his native country, and by such conduct prevented the re-erection of the Albion mills, and the general establishment of saw-mills through the kingdom; but their sovereignty perhaps will not be roused by so easy and simple a contrivance as this to lessen the quantity of manual labour. For an account of the Dutch oil-mill, which was somehow omitted in its proper place in the *Encyclopædia*, see OIL-MILL in this Supplement.

Mills,

MINERALOGY

¹
Definition. IS a science, the object of which is the description and arrangement of *inorganic bodies* or *minerals*; or of *all* the bodies which belong to our globe, excepting *animal* and *vegetable* substances.

Since the publication of the article MINERALOGY, *Encycl.* scarcely a single day has passed without the discovery of some new mineralogical fact, or the detection of some old and unsuspected error. These improvements cannot be overlooked in the present Supplement. But they are so numerous in every part of the science, that we can hardly notice them without giving a pretty complete view of the present state of mineralogy. This will scarcely occupy more room, and must be much more useful as well as entertaining, than an undigested mass

of annotations and remarks. We undertake this task the more readily, because in the article MINERALOGY in the *Encyclopædia*, the improvements of Mr Werner and his disciples, to which the science is indebted for a great part of its present accuracy, have been entirely overlooked.

The object of mineralogy is twofold. 1. To describe every mineral with so much accuracy and precision, that it may be easily distinguished from every other mineral. 2. To arrange them into a system in such a manner that every mineral may be easily referred to its proper place, and that a person may be able, merely by the help of the system, to discover the name of any mineral whatever. When these two objects are accomplished, mineralogy,

²
Object.

Description
of Minerals.

Mineralogy, strictly so called, is completed. But were we to stop here, the utility of the science, if it would be entitled to the name of science, could hardly be considered as very great. We must therefore apply *chemistry* to discover the ingredients of which minerals are composed, and to detect, if possible, the laws which these ingredients have observed in their combination. Thus we shall really extend our knowledge of inorganic nature, and be enabled to apply that knowledge to the improvement of almost every art and manufacture.

Division of
the article.

Mineralogy naturally divides itself into three parts. The *first* treats of the method of describing minerals; the *second*, of the method of arranging them; and the *third* exhibits them in a system described and arranged according to the rules laid down in the two first parts. These three parts shall be the subjects of the following chapters; and we shall finish the article with a chapter on the chemical analysis of minerals.

CHAP. I. OF THE DESCRIPTION OF MINERALS.

Nothing, at first sight, appears easier than to describe a mineral, and yet, in reality, it is attended with a great deal of difficulty. The mineralogical descriptions of the ancients are so loose and inaccurate, that many of the minerals to which they allude cannot be ascertained; and consequently their observations, however valuable in themselves, are often, as far as respects us, altogether lost. It is obvious, that to distinguish a mineral from every other, we must either mention some peculiar property, or a collection of properties, which exist together in no other mineral. These properties must be described in terms rigidly accurate, which convey precise ideas of the very properties intended, and of no other properties. The smallest deviation from this would lead to confusion and uncertainty. Now it is impossible to describe minerals in this manner, unless there be a peculiar term for each of their properties; and unless this term be completely understood. Mineralogy therefore must have a language of its own; that is to say, it must have a *term* to denote every mineralogical property, and each of these terms must be accurately defined. The language of mineralogy was invented by the celebrated Werner of Freyberg, and first made known to the world by the publication of his treatise on *The External Characters of Minerals*. Of this language we shall give a view in the following general description of the properties of minerals (A).

Properties
of minerals.

The properties of minerals may be divided into two classes. 1st, Properties discoverable without destroying the texture of the mineral; 2^d, Properties resulting from the action of other bodies on it. The first class has, by Werner and his disciples, been called *external* properties, and by some French writers *physical*; the second class has been called *chemical*.

The *external* properties may be arranged under the following heads:

SUPPL. VOL. II. Part I.

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|------------------|----------------|------------------|
| 1. Figure, | 8. Ductility, | 14. Sound, |
| 2. Surface, | 9. Fracture, | 15. Smell, |
| 3. Transparency, | 10. Texture, | 16. Taste, |
| 4. Colour, | 11. Structure, | 17. Gravity, |
| 5. Scratch, | 12. Fragments, | 18. Magnetism, |
| 6. Lustre, | 13. Feel, | 19. Electricity. |
| 7. Hardness, | | |

External
Characters.

5
Figure.

I. By *FIGURE* is meant the shape or form which a mineral is observed to have. The *figure* of minerals is either *regular*, *particular*, or *amorphous*. 1. Minerals which assume a regular figure are said to be crystallized*. The *sides* of a crystal are called *faces*; the sharp line formed by the inclination of two faces is called an *edge*; and the corner, or angle, formed by the meeting of several edges in one point, is called a *solid angle*, or simply *an angle*. Thus a cube has six faces, twelve edges, and eight angles. 2. Some minerals, though not crystallized, affect a *particular* figure. These particular figures are the following: *Globular*, like a globe; *oval*, like an oblong spheroid; *ovate*, like an egg; *cheese-shaped*, a very flattened sphere; *almond-shaped*, like an almond; *centicular*, like a double convex lens, compressed and gradually thinner towards the edges; *cuneiform*, like a wedge; *nodulous*, having depressions and protuberances like a potatoe; *botryoidal*, like grapes closely pressed together; *dentiform*, longish and tortuous, and thicker at the bottom than the top; *wireform*, like a wire; *capillary*, like hair, finer than the preceding; *retiform*, threads interwoven like a net; *dendritic*, like a tree, having branches issuing from a common stem; *shrubform*, branches not arising from a common stem; *coraloidal*, branched like coral; *stalactitical*, like icicles; *clavated*, like a club, long, and thicker at one end than another; *fasciform*, long straight cylindrical bodies, united like a bundle of rods; *tubular*, cylindrical and hollow. 3. When minerals have neither a regular nor particular shape, they are said to be *amorphous*.

6
Surface.

II. By *SURFACE* is meant the appearance of the external surface of minerals. The *surface* is either *uneven*, composed of small unequal elevations and depressions; *scabrous*, having very small sharp and rough elevations, more easily felt than seen; *drusy*, covered with very minute crystals; *rough*, composed of very minute blunt elevations, easily distinguishable by the feel; *scaly*, composed of very minute thin scale-like leaves; *smooth*, free from all inequality or roughness; *specular*, having a smooth polished surface like a mirror; or *streaked*, having elevated, straight, and parallel lines. This last character is confined to the *surface* of crystals. The *streaks* are either *transverse*; *longitudinal*; *alternate*, in different directions on different faces; *plumose*, running from a middle rib; or *decussated*, crossing each other.

III. By *TRANSPARENCY* is meant the proportion of light which minerals are capable of transmitting. They are *transparent* or *pellucid* when objects can be seen distinctly through them; *diaphanous*, when objects are

B b seen

(A) The fullest account of Werner's external characters which we have seen in the English language, has been given by Dr Townson in his *Philosophy of Mineralogy*. We have availed ourselves of this book, in order to exhibit some of the latest improvements of Werner and his disciples. The reader may also consult *Werner's Treatise*, published at Leipzig in 1774; or the *French translation* published at Dijon in 1790. See also *Romé de Lisle. Des Caractères Extérieur des Minéraux. And Haüy Jour. d'Hist. Nat. II. 56.*

External Characters. seen through them indistinctly; *subdiaphanous*, when light passes but in so small a quantity that objects cannot be seen through them (B); *opaque*, when no light is transmitted.

When opaque minerals become transparent in water, they are called *hydrophanous*. When objects are seen double through a transparent mineral, it is said to *refract doubly*.

8
Colour.

IV. The colours of minerals may be reduced to eight classes.

1. Whites.

Snow white. Pure white.
Reddish white. White with a light tint of red.
Yellowish white. White with a light tint of yellow.
Silver white. Yellowish white with a metallic lustre.
Greyish white. White with a light tint of black.
Greenish white. White with a light tint of green.
Milk white. White with a light tint of blue.
Tin white. Milk white of a metallic lustre.

2. Greys.

Bluish grey. Grey with a little blue.
Lead grey. Bluish grey with a metallic lustre.
Pearl grey. Light grey with a slight mixture of violet blue.
Smoke grey. Dark grey with a little blue and brown.
Greenish grey. Light grey tinged with green.
Yellowish grey. A light grey tinged with yellow.
Steel grey. A dark grey with a light tint of yellow and a metallic lustre.
Black grey. The darkest grey with a tint of yellow.

3. Blacks.

Greyish black. Black with a little white.
Brownish black. Black with a tint of brown.
Black. Pure black.
Iron black. Pure black with a small mixture of white and a metallic lustre.
Bluish black. Black with a tint of blue.

4. Blues.

Indigo blue. A dark blackish blue.
Prussian blue. The purest blue.
Azure blue. A bright blue with scarce a tint of red.
Smalt blue. A light blue.
Violet blue. A mixture of azure blue and carmine.
Lavender blue. Violet blue mixed with grey.
Sky blue. A light blue with a slight tint of green.

5. Greens.

Verdigris green. A bright green of a bluish cast.
Seagreen. A very light green, a mixture of verdigris green and grey.
Beryl green. The preceding, but of a yellowish cast.
Emerald green. Pure green.
Grass green. Pure green with a tint of yellow.
Apple green. A light green formed of verdigris green and white.
Leek green. A very dark green with a cast of brown.
Blackish green. The darkest green, a mixture of leek green and black.

Pistachio green. Grass green, yellow and a little brown. External Characters.

Olive green. A pale yellowish green with a tint of brown.

Asparagus green. The lightest green, yellowish with a little brown and grey.

6. Yellows.

Sulphur yellow. A light greenish yellow.
Brass yellow. The preceding, with a little less green and a metallic lustre.
Lemon yellow. Pure yellow.
Gold yellow. The preceding with a metallic lustre.
Honey yellow. A deep yellow with a little reddish brown.
Wax yellow. The preceding, but deeper.
Pyritaceous. A pale yellow with grey.
Straw yellow. A pale yellow, a mixture of sulphur yellow and reddish grey.
Wine yellow. A pale yellow with a tint of red.
Ochre yellow. Darker than the preceding, a mixture of lemon yellow with a little brown.
Isabella yellow. A pale brownish yellow, a mixture of pale orange with reddish brown.
Orange yellow. A bright reddish yellow, formed of lemon yellow and red.

7. Reds.

Aurora red. A bright yellow red, a mixture of scarlet and lemon yellow.
Hyacinth red. A high red like the preceding, but with a shade of brown.
Brick red. Lighter than the preceding; a mixture of aurora red and a little brown.
Scarlet red. A bright and high red with scarce a tint of yellow.
Copper red. A light yellowish red with the metallic lustre.
Blood red. A deep red, a mixture of crimson and scarlet.
Carmine red. Pure red verging towards a cast of blue.
Cochineal red. A deep red; a mixture of carmine with a little blue and a very little grey.
Crimson red. A deep red with a tint of blue.
Flesh red. A very pale red of the crimson kind.
Rose red. A pale red of the cochineal kind.
Peach blossom red. A very pale whitish red of the crimson kind.
Mordoré. A dark dirty crimson red; a mixture of crimson and a little brown.

Brownish red. A mixture of blood red and brown.

8. Browns.

Reddish brown. A deep brown inclining to red.
Clove brown. A deep brown with a tint of carmine.
Yellowish brown. A light brown verging towards ochre yellow.
Umber brown. A light brown, a mixture of yellowish brown and grey.
Hair brown. Intermediate between yellow brown and clove brown with a tint of grey.
Tombac brown. A light yellowish brown, of a metallic lustre, formed of gold yellow and reddish brown.

Liver

(B) After Mr Kirwan, we have denoted these three degrees of transparency by the figures 4, 3, 2. When a mineral is subdiaphanous only at the edges, that is denoted by the figure 1. Opacity is sometimes denoted by 0.

^{External Characters.} Liver brown. A dark brown; blackish brown with a tint of green.

Blackish brown. The darkest brown.

Colours, in respect of intensity, are either *dark*, *deep*, *light*, or *pale*. When a colour cannot be referred to any of the preceding, but is a mixture of two, this is expressed, by saying, that the prevailing one *verges* towards the other, if it has only a small tint of it; *passes* into it, if it has a greater.

⁹ Streak. V. By the SCRATCH or STREAK, is meant the mark left when a mineral is scratched by any hard body, as the point of a knife. It is either *similar*, of the same colour with the mineral; or *dissimilar*, of a different colour.

¹⁰ Lustre. VI. LUSTRE, is the gloss, or brightness which appears on the external surface of a mineral, or on its internal surface when fresh broken. The first is called *external*, the second *internal* lustre. Lustre is either *common*, that which most minerals possess; *silky*, like that of silk or mother-of-pearl; *waxy*, like that of wax; *greasy*, like that of grease; or *metallic*, like that of metals.

As to the degree, the greatest is called *splendent*, the next *shining*, the third *dullish*; and when only a few scattered particles shine, the lustre is called *dull* (c).

¹¹ Hardness. VII. We have used figures to denote the comparative HARDNESS of bodies; for an explanation of which, we refer to the article CHEMISTRY, Vol. I. p. 226. of this Supplement.

¹² Ductility and brittleness. VIII. With respect to DUCTILITY and BRITTLENESS, minerals are either *malleable*; *scissile*, capable of being cut without breaking, but not malleable; *flexile*, capable of being bent, and when bent retaining their shape; or *elastic*, capable of being bent, but recovering their former shape. Minerals destitute of these properties are *brittle*. Brittle minerals, with respect to the ease with which they may be broken, are either *very tough*, *tough*, *fragile*, or *very fragile*.

¹³ Fracture. IX. By FRACTURE is meant the fresh surface which a mineral displays when broken. It is either *flat*, without any general elevation or depression; or *conchoidal*, having wide extended roundish hollows and gentle risings. When these are not *very* evident, the fracture is called *flat* conchoidal; when they are small, it is called *small* conchoidal; and when of great extent, *great* conchoidal.

The fracture may also be *even*, free from all asperities; *uneven*, having many small, sharp, abrupt, irregular elevations and inequalities; and from the size of these, this fracture is denominated *coarse*, *small*, or *fine*; *splintery*, having small, thin, half detached, sharp edged splinters, according to the size of which this fracture is denominated *coarse* or *fine*; or *rugged*, having many very minute sharp hooks, more sensible to the hand than the eye.

¹⁴ Texture. X. By TEXTURE is meant the internal structure or disposition of the matter of which a mineral is composed, which may be discovered by breaking it. The texture is either *compact*, without any distinguishable parts, or the appearance of being composed of smaller parts; *earthy*, composed of very minute *almost* imperceptible rough parts; *granular*, composed of small shapeless grains;

globuliform, composed of small spherical bodies; *fibrous*, composed of fibres which may be *long*, *short*, *straight*, *crooked*, *parallel*, *divergent*, *stellated*, *fasciculated*, or *decussated*; *radiated*, consisting of long narrow flattish lamellæ; or *lamellar* or *foliated*, consisting of smooth continued plates covering each other; these plates may be either *straight*, *crooked*, or *undulating*.

¹⁵ Structure. XI. The STRUCTURE or COMPOUND TEXTURE is the manner in which the parts that form the texture are disposed. It is either *flaty*, in straight layers like slate; *testaceous*, in incurvated layers; *concentric*, in concentric layers; or *columnar*, in columns.

The texture and structure may at first view appear the same; but in reality they are very different. Thus common slate has often the *flaty* structure and *earthy* texture. The texture of pitcoal is compact, but its structure is often flaty.

¹⁶ Fragments. XII. By FRAGMENTS is meant the shape of the pieces into which a mineral breaks when struck with a hammer. They are either *cubic*; *rhomboidal*; *wedged*; *splintery*, thin, long, and pointed; *tabular*, thin, and broad, and sharp at the corners, as common slate; or *indeterminate*, without any particular resemblance to any other body. The edges of indeterminate fragments are either *very sharp*, *sharp*, *sharpish*, or *blunt*.

¹⁷ Feel. XIII. By the FEEL of minerals is meant the sensation which their surfaces communicate when handled. The feel of some minerals is *greasy*, of others, *dry*, &c.

¹⁸ Sound. XIV. Some minerals when struck give a *clear* SOUND, as common slate; others a *dull* sound.

The SMELL, TASTE, SPECIFIC GRAVITY, and MAGNETISM of minerals, require no explanation.

With respect to ELECTRICITY, some minerals become electric when *beated*, others when *rubbed*, others cannot be rendered electric. The electricity of some minerals is *positive* or *vitreous*, of others *negative* or *resinous*.

As for the CHEMICAL properties of minerals, they have been already explained in the article CHEMISTRY, which makes a part of this Supplement. And for the description of the blow-pipe, and the manner of using it, we refer the reader to a treatise on that subject prefixed to the article MINERALOGY in the *Encyclopædia*.

CHAP. II. OF THE ARRANGEMENT OF MINERALS.

MINERALS may be arranged two ways, according to their external characters, and according to their chemical composition. The first of these methods has been called an *artificial* classification; the second, a *natural* one. The first is indispensably necessary for the student of nature; the second is no less indispensable for the proficient who means to turn his knowledge to account. Without the first, it is impossible to discover the names of minerals; and without the second, we must remain ignorant of their use.

Almost every system of mineralogy hitherto published, at least since the appearance of Werner's *external characters*, has attempted to combine these two arrangements, and to obtain at one and the same time the advantages peculiar to each. But no attempt of this kind has hitherto succeeded. Whether this be owing to any thing impossible in the undertaking, or to the present

Bb 2

(c) These four degrees have been denoted by Kirwan by the figures 4, 3, 2, 1, and no lustre by 0. We have imitated him in the present article.

Artificial
System.

present imperfect state of mineralogy, as is more probable, we do not take upon us to determine. But surely the want of success, which has hitherto attended all attempts to combine the two arrangements, ought to suggest the propriety of separating them. By adhering strictly to one language, the trouble of studying two different systems would be entirely prevented. They would throw mutual light upon each other; the artificial system would enable the student to discover the names of minerals; the natural would enable him to arrange them, and to study their properties and uses.

The happy arrangement of Cronstedt, together with the subsequent improvements of Bergman, Werner, Kirwan, Haüy, and other celebrated mineralogists, has brought the natural system of mineralogy to a considerable degree of perfection. But an artificial system is still a desideratum; for excepting Linnæus, whose success was precluded by the state of the science, no one has hitherto attempted it. Though we are very far from thinking ourselves sufficiently qualified for undertaking such a task, we shall nevertheless venture, in the next chapter, to sketch out the rudiments of an artificial system. The attempt, at least, will be laudable, even though we should fail.

CHAP. III. ARTIFICIAL SYSTEM.

19
Artificial
classes.

MINERALS may be divided into six classes:

1. Minerals that cannot be fused by the blow-pipe *per se*.
2. Minerals fusible *per se* by the blow-pipe.
3. Minerals fusible by the blow-pipe *per se* when exposed to the blue flame, but not when exposed to the yellow flame.
4. Minerals fusible *per se* by the blow-pipe; and when in fusion, partly evaporating in a visible smoke.
5. Minerals which totally evaporate before the blow-pipe.
6. Minerals totally soluble in muriatic acid with effervescence, the solution colourless.

Under these heads we shall arrange the subjects of the mineral kingdom.

CLASS I. INFUSIBLE.

ORDER I. Specific gravity from 16 to 12.

GENUS I. Colour whitish iron grey.
Species 1. Native platinum.

ORDER II. Sp. gr. 8.5844 to 7.006.

GENUS I. Attracted by the magnet.
Sp. 1. Native iron.

GENUS II. Not attracted by the magnet.

Sp. 1. Native copper.
Flexible and malleable. Colour usually red.

Sp. 2. Wolfram.
Brittle. Colour usually brown or black.

ORDER III. Sp. gr. from 6.4509 to 5.8.

GENUS I. Forms a blue glass with microcosmic salt, which becomes colourless in the yellow, but recovers its colour in the blue flame.

Sp. 1. Tungstat of lime.

GENUS II. Forms with microcosmic salt a permanently coloured bead.

Sp. 1. Sulphuret of cobalt.

ORDER IV. Sp. gr. from 4.8 to 4.5.

GENUS I. Tinges borax dark green.

Sp. 1. Common magnetic iron stone.

GENUS II. Tinges borax reddish brown.

Sp. 1. Grey ore of manganese.

ORDER V. Sp. gr. from 4.4165 to 3.092. Infusible with fixed alkalies.

GENUS I. Hardness 20.

Sp. 1. Diamond.

GENUS II. Hardness 15 to 17. Causes single refraction.

Sp. 2. Telefia.

Sp. 2. Corundum.

GENUS III. Hardness 13. Single refraction.

Sp. 1. Ruby.

CrySTALLIZES in octahedrons.

GENUS IV. Hardness 12. Single refraction.

Sp. Chrysoberyl.

GENUS V. Hardness 12. Causes double refraction. Becomes electric when heated.

Sp. 1. Topaz.

GENUS VI. Hardness 10 to 16. Double refraction. Sp. gr. 4.2 to 4.165.

Sp. 1. Zircon.

GENUS VII. Hardness 6 to 9. Feels greasy.

Sp. 1. Cyanite.

GENUS VIII. Hardness 9 to 10. Feel not greasy. Double refraction. Sp. gr. 3.283 to 3.285.

Sp. 1. Chrysolite.

GENUS IX. Hardness 12. Infusible with borax. Colour of large masses black, of thin pieces deep green.

Sp. 1. Cylanite.

(Phosphat of lime.)

ORDER VI. Sp. gr. from 2.9829 to 1.987. Infusible with fixed alkalies.

GENUS I. Hardness 12.

Sp. 1. Emerald.

GENUS II. Hardness 10.

Sp. 1. Jade.

GENUS III. Hardness 6 to 7. Somewhat transparent.

Sp. 1. Phosphat of lime.

Before the blow-pipe becomes surrounded with a luminous green vapour.

GENUS IV. Hardness 6. Opaque.

Sp. 1. Micarelle.

GENUS V. Stains the fingers. Colour lead grey.

Sp. 1. Plumbago.

Spanish wax rubbed with plumbago does not become electric; or if it does, the electricity is negative. Streak lead grey even on earthen ware.

ORDER VII. Sp. gr. from 4.7385 to 4.569. Fusible with fixed alkalies.

GENUS I. Stains the fingers. Colour lead grey.

Sp. 1. Molybdena.

Spanish wax rubbed with molybdena becomes positively electric. Streak on earthen ware yellowish green.

ORDER VIII. Sp. gr. from 4.1668 to 2.479. Fusible with fixed alkalies.

* Hardness from 10 to 12.

GENUS

GENUS I. Usually white. Crystals dodecahedrons. Double refraction. Fracture imperfectly conchoidal or splintery. Brittle.

Sp. 1. Quartz.

GENUS II. Usually dark brown. Fracture perfectly conchoidal. Brittle. Easily breaks into splinters.

Sp. 1. Flint.

GENUS III. Not brittle. Fracture even or imperfectly conchoidal.

Sp. 1. Chalcedony.

Sp. 2. Jasper.

GENUS IV. Forms with potash a violet glass, with soda or borax a brown glass, with microcosmic salt a honey yellow glass. Colour green. Amorphous.

Sp. 1. Chrysoprasium.

GENUS V. Tinges soda red. The colour disappears before the blue flame, and returns before the yellow flame.

Sp. 1. Oxide of manganese and barytes.

Sp. 2. Black ore of manganese.

Sp. 3. Carbonat of manganese.

(Brown ore of iron. Red ore of iron.)

** Hardness 9 to 3.

GENUS VI. Flexible and elastic in every direction.

Sp. 1. Elastic quartz.

GENUS VII. Emits white flakes before the blow-pipe.

Sp. 1. Blende.

GENUS VIII. Becomes electric when heated.

Sp. 1. Calamine.

GENUS IX. Tinges borax green. Blackens before the blow-pipe.

Sp. 1. Mountain blue.

Colour blue.

Sp. 2. Green carbonat of copper.

Colour green.

GENUS X. Tinges borax green. Becomes attractable by the magnet by the action of the blow-pipe.

Sp. 1. Brown iron ore.

Colour brown.

Sp. 2. Red iron ore.

Colour red.

GENUS XI. Tinges borax smutty yellow. Becomes brownish black before the blow-pipe.

Sp. 1. Carbonat of iron.

GENUS XII. Feels greasy.

Sp. 1. Steatites.

(Black ore of Manganese. Carbonat of manganese. Mica.)

ORDER IX. Sp. gr. from 2.39 to 1.7.

GENUS I. Lustre glassy.

Sp. 1. Opal.

Sp. 2. Hyalite.

GENUS II. Lustre greasy.

Sp. 1. Pitchstone.

GENUS III. Lustre waxy or pearly.

Sp. 1. Staurolite.

CLASS II. FUSIBLE.

ORDER I. Sp. gr. from 19 to 10.

GENUS I. Colour yellow.

Sp. 1. Native gold.

GENUS II. Colour white.

Sp. 1. Native silver.

GENUS III. Colour yellowish white.

Sp. 1. Alloy of silver and gold.

ORDER II. Sp. gr. from 7.786 to 4.5.

GENUS I. Flexible and malleable.

Sp. 1. Sulphuret of silver.

** Brittle.

GENUS II. Tinges borax white.

Sp. Tinstone.

GENUS III. Tinges borax green.

Sp. 1. Sulphuret of copper.

Colour bluish grey.

Sp. 2. Chromat of lead.

Colour aurora red.

Sp. 3. Purple copper ore.

Colour purple.

GENUS IV. Tinges borax faint yellow. Becomes black when exposed to the vapour of sulphuret of ammonia.

Sp. 1. Galena.

Colour bluish grey. Lustre metallic.

Fragments cubic.

Sp. 2. Black lead ore.

Colour black. Lustre metallic.

Sp. 3. Lead ochre.

Colour yellow, grey, or red. Lustre o.

Sp. 4. Carbonat of lead.

Colour white. Lustre waxy.

Sp. 5. Phosphat of lead.

Usually green. Lustre waxy. After fusion by the blow-pipe crystallizes on cooling.

Sp. 6. Molybdat of lead.

Colour yellow. Streak white. Lustre waxy.

ORDER III. Sp. gr. from 4.35 to 3.

* Hardness 14 to 9.

GENUS I. Melts without frothing into a grey enamel.

Sp. 1. Garnet.

Colour red.

GENUS II. Melts into a brownish enamel.

Sp. 1. Shorl.

Colour black. Opaque.

GENUS III. Froths and melts into a white enamel.

Sp. 1. Tourmaline.

Becomes electric by heat.

GENUS IV. Froths and melts into a greenish black enamel.

Sp. 1. Basaltine.

GENUS V. Froths and melts into a black enamel.

Sp. 1. Thallite.

Colour dark green.

Sp. 2. Thumerstone.

Colour clove brown.

** Hardness 5 to 8.

GENUS VI. Melts into a transparent glass.

Sp. 1. Fluat of lime.

Powder phosphoresces when thrown on a hot iron.

GENUS VII. Melts into a black glass.

Sp. 1.

Sp. 1. Hornblende.

GENUS VIII. Melts into a black bead with a sulphureous smell, and deposits a blue oxide on the charcoal.

Sp. 1. Sulphuret of tin.

GENUS IX. Melts into a brown glass. Tinges borax violet.

Sp. 1. Asbestoid.

Colour green.

GENUS X. Melts into a brown (?) glass. When fused with potash, and dissolved in water, the solution becomes of a fine orange yellow.

Sp. 1. Chromat of iron.

GENUS XI. Before the blow-pipe yields a bead of copper.

Sp. 1. Red oxide of copper.

(Sulphuret of copper.)

ORDER IV. Sp. gr. from 2.945 to 2.437.

GENUS I. Composed of scales.

Sp. 1. Talk.

Feels greasy. Spanish wax rubbed by it becomes positively electric.

GENUS II. Composed of thin plates, easily separable from each other.

Sp. 1. Mica.

Plates flexible and elastic, may be torn but not broken. Spanish wax rubbed by it becomes negatively electric.

Sp. 2. Stilbite.

Plates somewhat flexible. Colour pearl white. Powder renders syrup of violets green. Froths and melts into an opaque white enamel.

Sp. 3. Lepidolite.

Colour violet. Powder white with a tint of red. Froths and melts into a white semitransparent enamel full of bubbles.

GENUS III. Texture foliated.

Sp. 1. Felspar.

Fragments rhomboidal. Hardness 9 to 10.

Sp. 2. Leucite.

Always crystallized. White. Powder renders syrup of violets green. Hardness 8 to 10.

Sp. 3. Argentinian felspar.

Always crystallized. Two faces dead white, two silvery white.

Sp. 4. Prehnite.

Colour green. Froths and melts into a brown enamel.

GENUS IV. Texture fibrous. Fibres easily separated.

Sp. 1. Asbestos.

Feels somewhat greasy.

GENUS V. Texture striated.

Sp. 1. Edelite.

Absorbs water. Froths and melts into a frothy mass.

GENUS VI. Texture earthy or compact.

Sp. 1. Lazulite.

Froths and melts into a yellowish

black mass. If previously calcined, gelatinizes with acids.

Sp. 2. Borat of lime.

Tinges the flame greenish, froths and melts into a yellowish enamel garnished with small projecting points. If the blast be continued, these dart off in sparks.

ORDER V. Sp. gr. from 2.348 to 0.68.

GENUS I. Hardness 10.

Sp. 1. Obsidian.

Colour blackish, in thin pieces green.

GENUS II. Hardness 6 to 8.

Sp. 1. Zeolite.

Gelatinizes with acids. Becomes electric by heat.

GENUS III. Hardness 3 to 4.

Sp. 1. Amianthus.

Feels greasy. Texture fibrous.

Sp. 2. Mountain cork.

Elastic like cork.

CLASS III. FUSIBLE BY THE BLUE FLAME, INFUSIBLE BY THE YELLOW.

GENUS I. Sp. gr. from 4.43 to 4.4.

Sp. 1. Sulphat of barytes.

GENUS II. Sp. gr. from 3.96 to 3.51.

Sp. 1. Sulphat of strontites.

GENUS III. Sp. gr. from 2.311 to 2.167.

Sp. 1. Sulphat of lime.

CLASS IV. FUSIBLE, AND PARTLY EVAPORATING.

ORDER I. Sp. gr. from 10 to 5.

GENUS I. Colour white or grey. Lustre metallic.

* Sp. gr. 9 to 10.

Sp. 1. Native amalgam.

Tinges gold white. Creaks when cut.

Sp. 2. Alloy of silver and antimony.

Powder greyish black.

** Sp. gr. from 6.467 to 5.309.

Sp. 3. Sulphuret of bismuth.

Melts when held to the flame of a candle.

Sp. 4. Dull grey cobalt ore.

Streak bluish grey. Hardness 10. When struck emits an arsenical smell. Lustre scarcely metallic.

GENUS II. Colour red, at least of the streak.

Sp. 1. Red silver ore.

Burns with a blue flame.

Sp. 2. Hepatic mercurial ore.

Does not flame, but gives out mercury before the blow-pipe.

GENUS III. Colour blue.

Sp. 1. Blue lead ore.

Burns with a blue flame and sulphureous smell, and leaves a button of lead.

GENUS IV. Colour yellowish green.

Sp. 1. Phosphat and arseniat of lead combined. When fused by the blow-pipe, crystallizes on cooling.

GENUS V. Colour usually that of copper. Sp.

gr.

Artificial
System.

gr. 6.6084 to 6.6481.

Sp. 1. Sulphuret of nickel.

Exhales before the blow-pipe an arsenical smoke.

ORDER II. Sp. gr. from 4.6 to 3.44.

GENUS I. Colour grey.

Sp. 1. Grey ore of antimony.

Burns with a blue flame, and leaves a white oxyd.

Sp. 2. Grey copper ore.

Crackles before the blow-pipe.

GENUS II. Colour yellow.

Sp. 1. Pyrites.

Burns with a blue flame and sulphureous smell, and leaves a brownish bead.

Sp. 2. Yellow copper ore.

Melts into a black mass.

CLASS V. EVAPORATING.

ORDER I. Sp. gr. 13.6.

GENUS I. Fluid.

Sp. 1. Native mercury.

ORDER II. Sp. gr. from 10 to 5.419.

GENUS I. Colour red.

Sp. 1. Native cinnibar.

GENUS II. Colour white or grey. Lustre metallic.

Sp. 1. Native bismuth.

Melts into a white bead, and then evaporates in a yellowish white smoke. Sp. gr. 9 to 9.5.

Sp. 2. Native antimony.

Melts and evaporates in a grey smoke. Sp. gr. 6.6 to 6.8.

Sp. 3. Native arsenic.

Evaporates without melting, and gives out a garlic smell.

ORDER III. Sp. gr. from 4.8 to 3.33.

GENUS I. Colour red.

Sp. 1. Red antimonial ore.

Melts with a sulphureous smell. Sp. gr. 4.7.

Sp. 2. Realgar.

Melts with a garlic smell. Sp. gr. 3.384.

GENUS II. Colour yellow.

Sp. 1. Orpiment.

CLASS VI. SOLUBLE WITH EFFERVESCENCE IN MURIATIC ACID.

Natural
System.

GENUS I. Sp. gr. from 4.338 to 4.3.

Sp. 1. Carbonat of barytes.

GENUS II. Sp. gr. from 3.66 to 3.4.

Sp. 1. Carbonat of strontites.

GENUS III. Sp. gr. from 2.8 to 1 or under.

Sp. 1. Carbonat of lime.

We have purposely avoided giving names to the classes, orders, and genera; because a more careful examination will doubtless suggest many improvements in the arrangement, and an artificial system ought to be brought to a great degree of perfection before its classes, orders, and genera be finally settled.

We have excluded from this arrangement all those bodies which in the following system are arranged under the class of combustibles; because there can scarcely be any difficulty in distinguishing them both from the other classes and from one another. For similar reasons we have excluded the class of salts.

CHAP. IV. NATURAL SYSTEM.

Avicenna, a writer of the 11th century, divided minerals into four classes; stones, salts, inflammable bodies, and metals (D). This division has been, in some measure, followed by all succeeding writers. Linnæus, indeed, the first of the moderns who published a system of mineralogy, being guided by the external characters alone, divided minerals into three classes, *petra*, *minera*, *fossilia*; but Avicenna's classes appear among his orders. The same remark may be made with respect to the systems of Wallerius, Wolsterdorf, Cartbeuser, and Justi, which appeared in succession after the first publication of Linnæus's *Systema Nature*, in 1736. At last in 1758, the system of Cronstedt appeared. He reinstated the classes of Avicenna in their place; and his system was adopted by Bergman, Kirwan, Werner, and the most celebrated mineralogists who have written since. We also shall adopt his classes, with a few slight exceptions; because we are not acquainted with any other division which is intitled to a preference.

We shall therefore divide this treatise into four classes. I. Stones. II. Salts. III. Combustibles. IV. Ores.

The first class comprehends all the minerals which are composed chiefly or entirely of earths; the second, all the combination of acids and alkalies which occur in the mineral kingdom; the third, those minerals which are capable of combustion, and which consist chiefly of sulphur, carbon, and oil; the fourth, the mineral bodies which are composed chiefly of metals.

20
Natural
Classes.

CLASS I. EARTHS AND STONES.

WE shall divide this class into three orders. The first order shall comprehend all chemical combinations of earths with each other; the second order, chemical combinations of earths with acids; and the third order, mechanical mixtures of earths or stones. All the minerals

belonging to the first order exhibit the same homogeneous appearance to the eye as if they were simple bodies. We shall therefore, for want of a better name, call the first order *simple*; the second order we shall distinguish by the epithet of *saline*; and the third we shall call

(D) Corpora mineralia in quatuor species dividuntur, scilicet in lapides, et in liquifactiva, sulphurea, et sales. Et horum quædam sunt raræ substantiæ et debilis compositionis, et quædam fortis substantiæ, et quædam ductibilia, et quædam non. *Avicenna de congelatione et conglutinatione lapidum*, Cap. 3. *Theatrum Chemicum* t. iv. p. 997.

Earthis and call *aggregates*; because most of the minerals belonging to it consist of various *simple stones*, cemented, as it were, together.

ORDER I. SIMPLE STONES.

21
Cronstedt's
genera.

CRONSTEDT divided this order into nine genera, corresponding to nine earths; one of which he thought composed the stones arranged under each genus. The names of his genera, were *calcareæ, filicæ, granatinæ, argillaceæ, micacæ, fluores, asbestinæ, zeolithicæ, magnesiæ*. All his earths were afterwards found to be compounds, except the first, second, fourth, and ninth. Bergman, therefore, in his *Sciagraphia*, first published in 1782, reduced the number of genera to five; which was the number of primitive earths known when he wrote. Since that period three new earths have been discovered. Accordingly, in the latest systems of mineralogy, the genera belonging to this order amount to eight. Each genus is named from an earth; and they are arranged in the newest Wernerian system, which we have seen, as follows:

- | | |
|------------------------|----------------------|
| 1. Jargon genus. | 5. Magnesian genus. |
| 2. Siliceous genus. | 6. Calcareous genus. |
| 3. Glucina genus. | 7. Barytic genus. |
| 4. Argillaceous genus. | 8. Strontian genus. |

Mr Kirwan, in his very valuable system of mineralogy, has adopted the same genera. Under each genus, those stones are placed, which are composed chiefly of the earth which gives a name to the genus, or which at least are supposed to possess the characters which distinguish that earth.

23
Still deficient.

A little consideration will be sufficient to discover that there is no natural foundation for these genera. Most stones are composed of two, three, or even four ingredients; and, in many cases, the proportion of two or more of these is nearly equal. Now, under what genus soever such minerals are arranged, the earth which gives it a name must form the smallest part of their composition. Accordingly, it has not been so much the chemical composition, as the external character, which has guided the mineralogist in the distribution of his species. The genera cannot be said properly to have any character at all, nor the species to be connected by any thing else than an arbitrary title. This defect, which must be apparent in the most valuable systems of mineralogy, seems to have arisen chiefly from an attempt to combine together an artificial and natural system. As we have separated these two from each other, it becomes necessary for us to attend more accurately to the natural distribution of genera than has hitherto been done. We have accordingly ventured to form new genera for this order, and we have formed them according to the following rules.

24
New genera.

The only substances which enter into the minerals belonging to this order, in such quantity as to deserve attention, are the following:

- | | |
|-----------|-------------------|
| Alumina, | Glucina, |
| Silica, | Zirconia, |
| Magnesia, | Oxide of iron, |
| Lime, | Oxide of chromum, |
| Barytes, | Potash, |

All those minerals which are composed of the same ingredients we arrange under the same genus. According to this plan, there must be as many genera as there are varieties of combinations of the above substances existing in nature. The varieties in the proportion of the ingredients constitute species. We have not imposed names upon our genera, but, in imitation of Bergman*, * *Opusc. iv.* have denoted each by a symbol. This symbol is composed of the first letter of every substance which enters in any considerable quantity into the composition of the minerals arranged under the genus denoted by it. Thus, suppose the minerals of a genus to be composed of *alumina, silica, and oxide of iron*, we denote the genus by the symbol *asi*. The letters are arranged according to the proportion of the ingredients; that which enters in the greatest proportion being put first, and the others in their order. Thus the genus *asi* is composed of a considerable proportion of alumina, of a smaller proportion of silica, and contains least of all of iron. By this contrivance, the symbol of a genus contains, within the compass of a few letters, a pretty accurate description of its nature and character. Where the proportions of the ingredients vary in the same genus so much, that the letters which constitute its symbol change their place, we subdivide the genus into parts; and whenever the minerals belonging to any genus become too numerous, advantage may be taken of these subdivisions, and each of them may be formed into a separate genus. At present this seems unnecessary (E).

The following is a view of the different genera belonging to this order, denoted each by its symbol. Every genus is followed by the species included under it; and the whole are in the order which we mean to follow in describing them:

- | | | | |
|-----------|--|-------------|---|
| I. A. | Telefia,
Corundum,
Native alumina. | VI. I. ASI. | Micarell,
Shorl,
Granatite, |
| II. AMC. | Ruby. | 2. SAI. | Tourmaline,
Argentine felspar,
Mica, |
| III. AIM. | Ceylanite. | | Talc,
Bastine,
Hornblende,
Obsidian,
Petrilite,
Felsite. |
| IV. S. | Quartz,
Elastic quartz,
Flint,
Opal,
Pitchstone,
Chrysoptasium. | VII. SAP. | Felspar,
Lepidolite,
Leucite. |
| V. I. AS. | Topaz,
Sommitite,
Shorlite. | VIII. SAG. | Emerald. |
| 2. SA. | Rubellite,
Hornslate,
Hornstone,
Chalcedony,
Jasper.
Tripoli. | IX. SAB. | Staurolite. |
| | | X. I. ASL. | Chrysoberyl. |
| | | 2. SAL. | Hyalite,
Edelite. |

3. SAWL.

(E) We need hardly remark, that the last three genera of Werner belong to the second order of the first class of this treatise.

Order I.

Earths and
Stones.

3. SAWL.	XV. SAMLI.
Zeolite,	Argillite.
Stilbite,	XVI. SM.
Analcime.	Kiffekill,
	Steatites.
4. SLA.	XVII. MSI.
Lazulite.	Chrysolite,
XI. SALI.	Jade.
Garnet,	XVIII. SML.
Thumerstone,	Asbestus,
Prehnite,	Asbestinite.
Thallite.	
XII. I. AMS.	XIX. I. SILM.
Cyanite.	Pyroxen,
2. MSA.	Asbestoid.
Serpentine.	2. SMIL.
XIII. MSAL.	Actinolite.
Pottstone,	XX. SL.
Chlorite.	Shiftose hornstone.
XIV. SLAM.	XXI. ZS.
Siliceous spar.	Zircon.

MINERALOGY.

are isosceles triangles, having the angle at their vertex $22^{\circ} 54'$, and each of those at the base $78^{\circ} 48'$ (G). The inclination of a side of one pyramid to a contiguous side of the other pyramid is $139^{\circ} 54' \frac{1}{2}$. In some specimens the summits of the pyramids are wanting, so that the crystal has the appearance of a six sided prism, somewhat thicker in the middle than towards the extremities §. The three alternate angles at each extremity of this prism are also sometimes wanting, and a small triangular face instead of them, which renders the bases of the supposed prism nine-sided. The inclination of each of these small triangles to the base is $122^{\circ} 18' \frac{1}{2}$. For figures of these crystals we refer the reader to Romé de Lisle and Haüy ||.

The texture of the telefia is foliated, and the joints are parallel to the base of the prism*. Its lustre varies from 3 to 4 (H). Transparency usually 3 or 4, sometimes only 2. It causes only a single refraction. Specific gravity from 4. to 4.288. Hardness from 15 to 17. It is either colourless or red, yellow or blue. These colours have induced lapidaries to divide the telefia into the three following varieties.

Variety 1. Red telefia.
Oriental ruby.

Colour carmine red, sometimes verging towards violet. Sometimes various colours appear in the same stone, as red and white, red and blue, orange red. Hardness 17. Sp. gr. 4.288.

Variety 2. Yellow telefia.
Oriental topaz.

Colour golden yellow. Transp. 4. Hardness 15. Sp. gr. 4.0106.

Variety 3. Blue telefia.
Oriental sapphyr.

Colour Berlin blue, often so very faint that the stone appears almost colourless. Transp. 3, 4, 2. Hardness 17. Sp. gr. 3.991 to 4.083 †. That variety is not † Greiville, probably the same with the sapphyr of the ancients, † Nicholson's, † Four. iii. 11. Their sapphyr was distinguished by gold-coloured spots, none of which are to be seen in the sapphyr of the moderns ‡.

A specimen of this last variety, analysed by Mr Klaproth, was found to contain in 100 parts,
98 5 alumina,
1.0 oxyd of iron,
0.5 lime,

100.0 §
§ Beitrüge, i. 81.

The colouring matter of all these varieties is, according to Bergman's experiments, iron in different states of oxydation. He found that the topaz contained .06, the ruby .1, and the sapphyr .02 of that metal ||. But when these experiments were made, the analysis of stones was not arrived at a sufficient degree of perfection to ensure accuracy. No conclusion, therefore, can be drawn from these experiments, even though we were certain that they were made upon the real varieties of telefia.

C c SPECIES

25
G. I. A.
Telefia.

GENUS I. A.

SPECIES I. Telefia (F).

Oriental ruby, sapphire, and topaz of mineralogists.—
Rubis d'orient of De Lisle.

Three stones, distinguished from each other by their colour, have long been held in high estimation on account of their hardness and beauty. These stones were known among lapidaries by the names of ruby, sapphire, and topaz, and the epithet oriental was usually added, to distinguish them from other three, known by the same names and the same colours, but very inferior in hardness and beauty. Mineralogists were accustomed to consider these stones as three distinct species, till Romé de Lisle observed that they agreed in the form of their crystals, their hardness, and most of their other properties. These observations were sufficient to constitute them one species; and accordingly they were made one species by Romé de Lisle himself, by Kirwan, and several other modern mineralogical writers. But this species was destitute of a proper name, till Mr Haüy, whose labours, distinguished equally by their ingenuity and accuracy, have contributed not a little to the progress of mineralogy, denominated it telefia, from the Greek word *τελεσιος*, which signifies perfect.

The telefia is found in the East Indies, especially in Pegu and the island of Ceylon; and it is most commonly crystallized. The crystals are of no great size: Their primitive form, according to Mr Haüy, is a regular six-sided prism, divisible in directions parallel both to its bases and its sides; and consequently giving for the form of its primitive nucleus, or of its integrant molecule, an equilateral three-sided prism*. The most usual variety is a dodecahedron, in which the telefia appears under the form of two very long slender six-sided pyramids, joined base to base †. The sides of these pyramids

* Ann de
Chim. xvii.
313.
† Plate
XXXVI.
Fig. 1.

SUPPL. VOL. II. Part I.

(F) See Kirwan's Mineralogy, I. 250.—Gmelin's Systema Naturæ of Linnaeus, III. 170.—Romé de Lisle's Crystallographie, II. 212.—Bermann's Opuscula, II. 72.

(G) In some instances, the angle at the vertex is 31° , those at the base $74^{\circ} 30'$, and the inclination of two triangles $122^{\circ} 36'$. See Haüy, *ibid*.

(H) When the kind of lustre is not specified, as in the present instance, the common is always meant.

Earths and

Stones.

26
Corundum.

SPECIES 2. Corundum (1).

Corundum of Gmelin—*Adamantine spar* of Klaproth and Kirwan *Corindon* of Haüy—*Corindum* of Woodward.

This stone, though it appears to have been known to Mr Woodward, may be said to have been first distinguished from other minerals by Dr Black. In 1768, Mr Berry, a lapidary in Edinburgh, received a box of it from Dr Anderson of Madras. Dr Black ascertained, that these specimens differed from all the stones known to Europeans; and, in consequence of its hardness, it obtained the name of *adamantine spar*. Notwithstanding this, it could scarcely be said to have been known to European mineralogists till Mr Greville of London, who has done so much to promote the science of mineralogy, obtained specimens of it, in 1784, from India, and distributed them among the most eminent chemists, in order to be analysed. Mr Greville also learned, that its Indian name was Corundum. It is found in Indostan, not far from the river Cavery, which is south from Madras, in a rocky matrix, of considerable hardness, partaking of the nature of the stone itself*. It occurs also in China; and a substance, not unlike the matrix of corundum, has been found in Tereë, one of the western islands in Scotland†.

* Garreau and Greville, *Nicholson's Jour.* ii. 540.† Greville, *ibid.*‡ *Jour. de Min.* N^o xxviii. 262.§ *Nicholson's Jour.* ii. 541.¶ *Fig. 3.*|| *Fig. 4.** *De Bournon.*

† See also

Haüy, Jour. de Min. N^o xxviii. 262.‡ *Klaproth*

See also

Mr Greville, Nicholson's Jour. iii. 11.§ *Beiträge,*

i. 77.

A specimen from China of

84.0 alumina,

6.5 filica,

7.5 oxide of iron,

98.0 ||.

|| *Ibid.* i. 73.

Notwithstanding the quantity of filica and of iron which these analyses exhibit in the corundum, we have been induced to include it in the present genus on account of the strong resemblance between it and the third variety of *telesia*. The striking resemblance between the crystals of *telesia* and corundum will appear evident, even from the superficial description which we have given; and the observations of De Bournon ¶ render this resemblance still more striking. It is not improbable, therefore, as Mr Greville and the Count de Bournon have suggested, that corundum may be only a variety of *telesia*, and that the seeming difference in their ingredients is owing to the impurity of those specimens of corundum which have hitherto been brought to Europe. Let not the difference which has been found in the primitive form of these stones be considered as an insuperable objection, till the subject has been again examined with this precise object in view; for nothing is easier than to commit an oversight in such difficult examinations.

¶ *Nicholson's Jour.* iii. 9.

SPECIES 3. Native alumina (κ).

27
Native alumina.

This substance has been found at Halles in Saxony in compact kidney-form masses. Its consistence is earthy. Lustre o. Opaque. Hardness 4. Brittle. Sp. gr. moderate. Feels soft, but meagre. Adheres very slightly to the tongue. Stains very slightly. Colour pure white. Does not readily diffuse itself in water.

It consists of pure alumina, mixed with a small quantity of carbonat of lime, and sometimes of sulphat of lime*.

* *Schreber.*

GENUS II. AMC.

SPECIES 1. Ruby (λ).

28
G. II. AMC.
Ruby.

Spinel and *balas* Ruby of Kirwan—*Ruby* of Haüy—*Rubis spinelle octoedre* of De Lisle—*Spinellus* of Gmelin.

This stone, which comes from the island of Ceylon, is usually crystallized. The primitive form of its crystals is a regular octohedron, composed of two four-sided pyramids applied base to base, each of the sides of which is an equilateral triangle † (m). In some cases † *Fig. 5.* two opposite sides of the pyramids are broader than the other two; and sometimes the edges of the octohedron are wanting, and narrow faces in their place. For figures and descriptions of these, and other varieties of these crystals, we refer the reader to *Romé de Lisle* and the *Abbé Estner* ‡.

‡ *Crystal.* ii.

The texture of the ruby is foliated. Its lustre is 3. 226. *Estner's Miner.* Transp. 3-4. It causes a single refraction. Hardness 13. Sp. gr. 3.570 § to 3.625 ¶. Colour red; if deep, the ruby is usually called *balas*; if pale rosy, *spinell*.

§ *Klaproth.* ¶ *Hatchett.* The and Greville.

(1) See Kirwan's *Mineralogy*, I.—Klaproth in *Beob. der Berlin*, VIII. 295, and *Beiträge*, I. 47.—Mr Greville and the Count de Bournon in the *Philosophical Transactions* 1798, p. 403, and in *Nicholson's Journal*, II. 540. and III. 5.—Mr Haüy *Jour. de Phys.* XXX. 193, and *Jour. de Min.* N^o XXVIII. 262.

(κ) See Kirwan's *Mineralogy*, I. 175, and *Schreber*. 15. *Stück*, p. 209.

(λ) See Kirwan's *Min.* I. 253.—*Romé de Lisle*, II. 224.—Klaproth *Beob. der Berlin*, III. 336. and *Beiträge*, II. 1.—*Vauquelin Ann. de Chim.* XXVII. 3, and XXXI. 141.

(m) We shall afterwards distinguish this octohedron either by the epithet *regular* or *aluminiform*, because it is the well-known form of crystals of alum.

Order I.

MINERALOGY.

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Earth and Stones. The ruby, according to the analysis of Vauquelin, is composed of

86.00 alumina,
8.50 magnesia,
5.25 chromic acid.

* *Ann. de Chim.* xxvii. 15. † *Plinii*, l. 37. c. 9. 29. The ancients seem to have classed this stone among their hyacinths †.

GENUS III. AIM.
SPECIES I. Ceylanite.

The mineral denominated *ceylanite*, from the island of Ceylon, from which it was brought into Europe, had been observed by Romé de Lisle †; but was first described by La Metherie in the *Journal de Physique* for January 1793.

It is most commonly found in rounded masses; but sometimes also crystallized. The primitive form of its crystals is a regular octahedron: it commonly occurs under this form, but more commonly the edges of the octahedron are wanting, and small faces in their place §.

The fracture of the ceylanite is conchoidal ||. Its internal lustre is glassy. Nearly opaque, except when in very thin pieces. Hardness 12. Sp. gr. from 3.7647* to 3.793 †. Colour of the mass, black; of very thin pieces, deep green. Powder, greenish grey. According to the analysis of Descotils, the ceylanite is composed of

68 alumina,
16 oxide of iron,
12 magnesia,
2 silica.
—
98 ‡

† *Ann. de Chim.* xxiii. 113.

GENUS IV. s.
SPECIES I. Quartz §.

This stone, which is very common in most mountainous countries, is sometimes crystallized, and sometimes amorphous. The primitive form of its crystals, according to Mr Haüy, is a rhomboidal parallelepiped; the angles of whose rhombs are $93^{\circ} 22'$, and $86^{\circ} 38'$; so that it does not differ much from a cube ||. The most common variety is a dodecahedron*, composed of two six-sided pyramids, applied base to base, whose sides are isosceles triangles, having the angle at the vertex 40° , and each of the angles at the base 70° ; the inclination of a side of one pyramid to the contiguous side of the other pyramid is 104° . There is often a six-sided prism interposed between the two pyramids, the sides of which always correspond with those of the pyramids †. For a description and figure of the other varieties of quartz crystals, and for a demonstration of the law which they have followed in crystallizing, we refer the reader to Romé de Lisle ‡ and Mr Haüy §.

† *Fig. 7.*
‡ *Crystall.* ii. 71.
§ *Mem. Par.* 1786, p. 78. See also *Lametherie, Jour. de Phys.* xiii. 470.
The texture of quartz is more or less foliated. Fracture, conchoidal or splintery. Its lustre varies from 3 to 1, and its transparency from 4 to 1; and in some cases it is opaque. It causes a double refraction. Hardness, from 10 to 11. Sp. gr. from 2.64 to 2.67, and in one variety 2.691. Its colour is exceedingly va-

rious; a circumstance which has induced mineralogists to divide it into numerous varieties. Of these the following are the chief:

1. Pure colourless, perfectly transparent crystallized quartz, having much the appearance of artificial crystal: known by the name of *rock crystal*.

2. Quartz less transparent, and with a splintery fracture, has usually been distinguished by the name of *quartz*, and separated from rock crystal. As there is no occasion for this separation, we have, in imitation of Mr Haüy, chosen the word quartz for the *specific name*, comprehending under it all the varieties.

3. Blood red quartz; formerly called *compsoella hyacinth*, and by Haüy *quartz hematoides*. It owes its colour to oxide of iron. The mineral known to mineralogists by the name of *sinople*, and considered by them as a variety of *jasper*, has been discovered by Dolomieu to be merely this variety of quartz in an amorphous state*.

4. Yellow quartz; called false topaz.

5. Rosy red quartz; called Bohemian ruby.

For a fuller enumeration of these varieties, we refer the reader to *Smeisser's Mineralogy* †, *Kirwan's Mineralogy* ‡, and Gmelin's edition of the *Systema Naturæ* of § i. 244. Linnæus §. This last writer, however, has arranged several minerals under quartz which do not belong to it.

Pure quartz is composed entirely of silica; but some of the varieties of this species are contaminated with metallic oxides, and with a small quantity of other earths.

SPECIES 2. Elastic Quartz (N).

This singular stone is moderately elastic, and flexible in every direction. Texture, earthy. Lustre 0 or 1. Hardness, 9. Brittle. Sp. gr. 2.624. Colour, greyish white. Phosphoresces when scraped with a knife in the dark. The specimen analysed by Mr Klaproth contained

96.5 silica,
2.5 alumina,
5 oxide of iron.

99.5 ||

SPECIES 3. Flint (O).

Pyromachus—*Pierre a fusil*—*Silex* of Haüy.

This stone, which has become so necessary in modern war, is found in pieces of different sizes, and usually of a figure more or less globular, commonly among chalk, and often arranged in some kind of order. In Saxony it is said to have been found crystallized in hexahedrons, composed of two low three-sided pyramids applied base to base*.

Its texture is compact. Its fracture, smooth conchoidal. Lustre, external, 0, the stones being always covered by a white crust; internal, 1, inclining to greasy. Transp. 2; when very thin, 3. Hardness, 10 or 11. Sp. gr. from 2.58 to 2.63. Colour varies from honey yellow to brownish black. Very brittle, and splits into splinters in every direction. Two pieces of flint rubbed smartly together phosphoresce, and emit a peculiar odour. When heated it decrepitates, and becomes white and opaque. When exposed long to the

C c 2

Simple Stones.

* *Jour. de Min.* N° xxviii. 255.

31
Elastic quartz.

|| *Beiträge*, ii. 116.

32
nt.

* *Gmelin's Systema Naturæ*, iii.

318.

air

(N) *Kirwan's Min.* I. 316.—*Gerhard, Mem. Berlin*, 1783, 107.—*Klaproth's Beiträge*, 2 Band. 113. See also *Jour. de Phys.* XLI. 91.

(O) *Kirwan's Min.* I. 301.—*Dolomieu, Jour. de Min.* N° XXXIII. 693. and *Salivet, ibid.* 713. These last gentlemen give the only accurate account of the method of making gun flints.

Earths and
Stones.

air it often becomes covered with a white crust. A specimen of flint, analysed by Klaproth, contained

98.00 silica,
.50 lime,
.25 alumina,
0.25 oxide of iron,
1.00 water.

* *Beiträge*,
i. 46.

100.00 *

Another specimen, analysed by Dolomieu, was composed of

97 silica,
1 alumina and oxide of iron,
2 water.

† *Jour. de*
Min. No
xxxiii. 702.

100 †

The white crust with which flint is enveloped, consists of the same ingredients, and also a little carbonat of lime. Dolomieu discovered that water is essential to flint; for when it is separated by heat the stone loses its properties †.

† *Ibid.*

The manufacture of gun flints is chiefly confined to two or three departments in France. The operation is exceedingly simple: a good workman will make 1000 flints in a day. The whole art consists in striking the stone repeatedly with a kind of mallet, and bringing off at each stroke a splinter, sharp at one end and thicker at the other. These splinters are afterwards shaped at pleasure, by laying the line at which it is wished they should break, upon a sharp iron instrument, and then giving it repeatedly small blows with a mallet. During the whole operation the workman holds the stone in his hand, or merely supports it on his knee §.

§ *Ibid.*33
Opal.

SPECIES 4. Opal (P).

This stone is found in many parts of Europe. It is usually amorphous. Its fracture is conchoidal, commonly somewhat transparent. Hardness from 6 to 10. Sp. gr. from 1.7 to 2.66. The lowness of its specific gravity, in some cases, is to be ascribed to accidental cavities which the stone contains. These are sometimes filled with drops of water. Some specimens of opal have the property of emitting various coloured rays, with a particular effulgency, when placed between the eye and the light. The opals which possess this property, are distinguished by lapidaries by the epithet *oriental*; and often by mineralogists by the epithet *nobilis*. This property rendered the stone much esteemed by the ancients.

Variety 1. Opal edler—*Opalus nobilis*.

Lustre glassy; 3. Transp. 3 to 2. Hardness, 6 to 8. Colour, usually light bluish white, sometimes yellow or green. When heated it becomes opaque, and sometimes is decomposed by the action of the atmosphere. Hence it seems to follow, that water enters essentially into its composition. A specimen of this variety, analysed by Klaproth, contained

90 silica,
10 water.

* *Beiträge*,
ii. 153.

100 *

Variety 2. Semi-opal.

Fracture, imperfectly conchoidal. Lustre, glassy, 2. Transp. 2 to 3. Hardness, 7 to 9. Its colours are very

various, greys, yellows, reds, browns, greens of different kinds.

Specimens of this variety sometimes occur with rifts: these readily imbibe water, and therefore adhere to the tongue. These specimens sometimes become transparent when soaked in water, by imbibing that fluid. They are then called *hydropphanes*.

Variety 3. Cat's eye *.

This variety comes from Ceylon, and is seldom seen by European mineralogists till it has been polished by the lapidary. Mr Klaproth has described a specimen which he received in its natural state from Mr Greville of London. Its figure was nearly square, with sharp edges, a rough surface, and a good deal of brilliancy.

Its texture is imperfectly foliated. Lustre greasy, 2. Transp. 3 to 2. Hardness 10. Sp. gr. 2.56 to 2.66. Colour, grey; with a tinge of green, yellow, or white; or brown, with a tinge of yellow or red. In certain positions it reflects a splendid white, as does the eye of a cat; hence the name of this stone.

Two specimens, analysed by Klaproth, the first from Ceylon, the other from Malabar, were composed of

95.00 94.50 silica,
1.75 2.00 alumina,
1.50 1.50 lime,
0.25 0.25 oxide of iron.

98.5 †

98 25 †

SPECIES 5. Pitchstone §.

Menelites.

This stone, which occurs in different parts of Germany, France, and other countries, has obtained its name from some resemblance which it has been supposed to have to pitch. It is most usually in amorphous pieces of different sizes; and it has been found also crystallized in six-sided prisms, terminated by three-sided pyramids.

Its texture is conchoidal and uneven, and sometimes approaches the splintery. Lustre greasy, from 3 to 1. Transp. 2 to 1, sometimes 0. Hardness 8 to 10. Exceedingly brittle; it yields even to the nail of the finger. Sp. gr. 2.049 to 2.39. Its colours are numerous, greyish black, bluish grey, green, red, yellow of different shades. Sometimes several of these colours appear together in the same stone. A specimen of pitchstone from Meunil-montant near Paris ||, analysed by Mr Klaproth, contained

85.5 silica,
11.0 air and water,
1.0 alumina,
.5 iron,
.5 lime and magnesia,
98.5 ¶

SPECIES 6. Chrysoprasium (Q).

This mineral, which is found in different parts of Germany, particularly near Kosemütz in Silesia, is always amorphous. Its fracture is either even or inclining to the splintery. Scarcely any lustre. Transp. 2 to 3. Hardness 10 to 12. Sp. gr. 2.479. Colour, green. In a heat of 130° Wedgewood it whitens and becomes opaque.

A

(P) Kirwan's *Min.* I. 289.—*Haüy, Jour. d'Hist. Nat.* II. 9.—*Delius, Nouv. Jour. de Phys.* I. 45.
(Q) Kirwan's *Min.* I.—*Lehmann, Mem. Berlin*, 1755, p. 202.—*Klaproth Beiträge*, II. 127.

Simple
Stones.* Kirwan's
Min. i. 301.
Klaproth,
Beiträge, i.
90.† *Beiträge*,
i. 94.
† *Ibid.*
p. 96.34
Pitchstone.
§ Kir. *Min.*
i. 292.—
Daubanton,
Mem. Par.
1787, p. 86.|| See *Jour.*
de Phys.
xxx. 219.¶ *Beiträge*,
ii. 109.35
Chrysoprasium.

MINERALOGY.

Order I.

Earths and Stones. A specimen of this stone, analysed by Mr Klaproth, contained

96.16 silica,
1.00 oxide of nickel,
0.83 lime,
0.08 alumina,
0.08 oxide of iron.

98.15 †

GENUS V. 1. AS.

SPECIES 1. Topaz (R).

Occidental ruby, topaz, and sapphyr.

The name *topaz* has been restricted by Mr Haüy to the stones called by mineralogists occidental ruby, topaz, and sapphyr; which, agreeing in their crystallization and most of their properties, were arranged under one species by Mr Romé de Lisle. The word *topaz*, derived from an island in the Red Sea (s), where the ancients used to find topazes, was applied by them to a mineral very different from ours. One variety of our topaz they denominated *chrysolite*.

The topaz is found in Saxony, Bohemia, Siberia, and Brazil, mixed with other minerals in granite rocks.

It is commonly crystallized. The primitive form of its crystals is a prism whose sides are rectangles, and bases rhombs, having their greatest angles $124^{\circ} 22'$, and the integral molecule has the same form †; and the height of the prism is to a side of the rhomboidal bases as 3 to 2 ‡. The different varieties of topaz crystals hitherto observed, amount to 6. Five of these are eight-sided prisms, terminated by four sided pyramids, or wedge shaped summits, or by irregular figures of 7, 13, or 15 sides §; the last variety is a twelve-sided prism, terminated by six-sided pyramids wanting the apex. For an accurate description and figure of these varieties we refer the reader to Mr Haüy ||.

The texture of the topaz is foliated. Its lustre is from 2 to 4. Transp. from 2 to 4. It causes a double refraction. Hardness 12 to 14. Sp. gr. from 3.5311 to 3.564. The Siberian and Brazil topazes, when heated, become positively electrified on one side, and negatively on the other ¶. It is infusible by the blow-pipe. The yellow topaz of Brazil becomes red when exposed to a strong heat in a crucible; that of Saxony becomes white by the same process. This shews us that the colouring matter of these two stones is different.

The colour of the topaz is various, which has induced mineralogists to divide it into the following varieties:

1. Red topaz, of a red colour inclining to yellow; called *Brazilian* or *occidental ruby*.

2. Yellow topaz, of a golden yellow colour, and sometimes also nearly white; called *occidental* or *Brazil topaz*. The powder of this and the following variety causes syrup of violets to assume a green colour *.

3. Saxon topaz. It is of a pale wine yellow colour, and sometimes greyish white.

4. *Aigue marine*. It is of a bluish or pale green colour.

5. *Occidental sapphyr*. It is of a blue colour; and sometimes white.

A specimen of white Saxon topaz, analysed by Vauquelin, contained

68 alumina,

3 silica.

99 *.

SPECIES 2. Sommite.

This stone was called sommite by La Metherie, from the mountain Somma, where it was first found. It is usually mixed with volcanic productions. It crystallizes in six-sided prisms, sometimes terminated by pyramids. Colour white. Somewhat transparent. Sp. gr. 3.2741. Infusible by the blow-pipe. According to the analysis of Vauquelin, it is composed of

49 alumina,

46 silica,

2 lime,

1 oxide of iron.

98 †

SPECIES 3. Shorlite ‡.

This stone, which received its name from Mr Klaproth, is generally found, in irregular oblong masses or columns, inserted in granite. Its texture is foliated. Fracture uneven. Lustre 2. Transparency 2 to 1. Hardness 9 to 10. Sp. gr. 3.53. Colour greenish white, or sulphur yellow. Not altered by heat. According to the analysis of Klaproth, it is composed of

50 alumina,

50 silica.

100

GENUS V. 2. SA.

SPECIES 4. Rubellite (r).

Red shorl of Siberia.

This stone is found in Siberia mixed with white quartz. It is crystallized in small needles, which are grouped together and traverse the quartz in various directions. Texture fibrous. Fracture even, inclining to the conchoidal. Transparency 2; at the edges 3. Hardness 10. Brittle. Sp. gr. 3.1. Colour crimson, blood or peach red. By exposure to a red heat it becomes snow white; but loses none of its weight. It tinges soda blue, but does not melt with it.

According to the analysis of Mr Bindheim, it is composed of

57 silica,

35 alumina,

5 oxides of iron and manganese.

97

SPECIES 5. Hornslate (v).

Shiflose porphyry.

This stone, which occurs in mountains, is generally amorphous; but sometimes also in columns. Structure

Simple Stones.

* *Four. de*

Min. N°

xxiv. 3.

37

Sommite.

† *Ibid. N°*

xxviii. 279.

38

† *Kirwan's*

Min. i. 286.

39

G. V. 2. SA.

Rubellite.

39

G. V. 2. SA.

Rubellite.

40

Hornslate.

† *Beiträge,*

ii. 133.

36

G. V. 1. AS.

Topaz.

† *Haüy,*

Four. de

Min. N°

xxviii. 287.

† *Fig. 8.*

§ *Fig. 9.*

|| *Four. de*

Min. ibid.

¶ *Haüy, ibid.*

* *Vauque-*

lin, Four. de

Min. N°

xxix. 165.

(R) *Kirwan's Min. I. 254.—Pott. Mem. Berlin, 1747, p. 46.—Margraf, ibid. 1776, p. 73. and 160.—Henkel. At. Acad. Nat. Cur. IV. 316.*

(s) It got its name from *τοπαζα, to seek*; because the island was often surrounded with fog, and therefore difficult to find. See *Plinii lb. 37. c. 8.*

(r) *Kirwan's Min. I. 288. Bindheim, Crell's Annals, 1792, p. 320.*

(v) *Kirwan's Min. I. 307.—Wiegleb, Crell's Annals, 1787. 1 Band. 302.—See also Reufs. Semml. Natur. Hist. Aufsätze, p. 207.*

Earths and
Stones.

ture flaty. Texture foliated. Fracture uneven and splintery; sometimes approaching the conchoidal. Lustre o. Transparency 1 or o. Hardness about 10. Sp. gr. from 2.512 to 2.7. Colour different shades of grey, from *ash* to *bluish* or *olive green*. Melts at 145° Wedgewood into an enamel. A specimen, analysed by Wedgewood, contained

73.0 silica,
23.9 alumina,
3.5 iron.

100.4

41
Hornstone.

SPECIES 6. Hornstone (x).
Petrofex—Chert.

This stone, which makes a part of many mountains, is usually amorphous; but, as Mr Kirwan informs us, it has been found crystallized by Mr Beyer on Schneeberg. Its crystals are six-sided prisms, sometimes terminated by pyramids: hexahedrons, consisting of two three-sided pyramids applied base to base; and cubes, or six-sided plates*. Its texture is foliated. Fracture splintery, and sometimes conchoidal. Lustre o. Transparency 1 to 2. The crystals are sometimes opaque. Hardness 7 to 9. Sp. gr. 2.532 to 2.653. Colour usually dark blue: but hornstone occurs also of the following colours; grey, red, blue, green, and brown of different shades†.

* Kirwan,
i. 303.† Schmei-
ser's Min.
i. 103.

According to Kirwan, it is composed of

72 silica,
22 alumina,
6 carbonat of lime.

100 ‡

‡ Ibid. p.
305.42
Chalcedony.

SPECIES 7. Chalcedony.

This stone is found abundantly in many countries, particularly in Iceland and the Faro islands. It is most commonly amorphous, stalactitical, or in rounded masses; but it occurs also crystallized in six-sided prisms, terminated by pyramids, or more commonly in four or six sided pyramids, whose sides are convex. Surface rough. Fracture more or less conchoidal. Lustre 1. Somewhat transparent. Hardness 10 to 11. Sp. gr. 2.56 to 2.665. Not brittle.

According to Bergman, the chalcedony of Foroe is composed of

84 silica,
16 alumina, mixed with iron.

100

Variety 1. Common chalcedony.

Fracture even, inclining to conchoidal. Transparency 2 to 3; sometimes 1. Its colours are various; it is most commonly greyish, with a tint of yellow, green, blue, or pearl; often also white, green, red, yellow, brown, black, or dotted with red. When striped white and black, or brown, alternately, it is called *onyx*; when striped white and grey, it is called *chalcedonix*. Black or brown chalcedony, when held between the eye and a strong light, appears dark red.

Variety 2. Cornelian.

Fracture conchoidal. Transparency 3 to 1; often cloudy. Its colours are various shades of red, brown,

and yellow. Several colours often appear in the same mass. To this variety belong many of the stones known by the name of *Scotch pebbles*.

SPECIES 8. Jasper (y).

This stone is an ingredient in the composition of many mountains. It occurs usually in large amorphous masses, and sometimes also crystallized in six-sided irregular prisms. Its fracture is conchoidal. Lustre from 2 to o. Either opaque, or its transparency is 1. Hardness 9 to 10. Sp. gr. from 2.5 to 2.82. Its colours are various. When heated, it does not decrepitate. It seems to be composed of silica and alumina, and often also contains iron.

Variety 1. Common jasper.

Sp. gr. from 2.58 to 2.7. Its colours are different shades of white, yellow, red, brown, and green; often variegated, spotted, or veined, with several colours.

Variety 2. Egyptian pebble.

This variety is found chiefly in Egypt. It usually has a spheroidal or flat rounded figure, and is enveloped in a coarse rough crust. It is opaque. Hardness 10. Sp. gr. 2.564. It is chiefly distinguished by the variety of colours, which always exist in the same specimen, either in concentric stripes or layers, or in dots or denticritical figures. These colours are, different browns and yellows, milk white, and isabella green; black also has been observed in dots.

Variety 3. Striped jasper.

This variety is also distinguished by concentric stripes or layers of different colours: these colours are, yellow, brownish red, and green. It is distinguished from the last variety by its occurring in large amorphous masses, and by its fracture, which is nearly even.

SPECIES 9. Tripoli.

This mineral is found sometimes in an earthy form, but more generally indurated. Its texture is earthy. Its fracture often somewhat conchoidal. Lustre o. Generally opaque. Hardness 4 to 7. Sp. gr. 2.080 to 2.529. Absorbs water. Feel, harsh dry. Hardly adheres to the tongue. Takes no polish from the nail. Does not stain the fingers. Colour generally pale yellowish grey, also different kinds of yellow, brown, and white.

It contains, according to Haasse, 90 parts of silica, 7 alumina, and 3 of iron. A mineral belonging to this species was analysed by Klaproth, and found to contain

66.5 silica,
7.0 alumina,
2.5 oxide of iron,
1.5 magnesia,
1.25 lime,
19. air and water.

97.75

GENUS VI. I. ASI.

SPECIES 1. Micarell*.

This name has been given by Mr Kirwan to a stone which former mineralogists considered as a variety of mica. It is found in granite. Its texture is foliated, and

Simple
Stones.43
Jasper.44
Tripoli.45
G. VI. 1.ASI.
Micarell.* Kirwan's
Min. i.

212.

(x) Kirwan's Min. I. 303.—Baumer, Jour. de Phys. II. 154. and Monnet, *ibid.* 331.—Wiegleb, Crel's Annals, 1788, p. 45. and 135.

(y) Kirw. Min. I. 309.—Borral Hist. Natur. de Corse.—Henkel *Ad. Acad. Nat. Curios.* V. 339.

Order I.

MINERALOGY.

Earths and Stones. and it may be split into thin plates. Lustre metallic, 3. Opaque. Hardness 6. Sp. gr. 2.980. Colour brownish black. At 153° Wedgewood, it melts into a black compact glass, the surface of which is reddish *.

* Kirw. *ibid.*

46
Shorl.
† *Ibid.* i.
265.

A specimen analysed by Klaproth contained
63.00 alumina,
29.50 silica,
6.75 iron.

99.25
SPECIES 2. Shorl †.

No word has been used by mineralogists with less limitation than *shorl*. It was first introduced into mineralogy by Cronstedt, to denote any stone of a columnar form, considerable hardness, and a specific gravity from 3 to 3.4. This description applied to a very great number of stones. And succeeding mineralogists, though they made the word more definite in its signification, left it still so general, that under the designation of *shorl* almost 20 distinct species of minerals were included.

Mr Werner first defined the word *shorl* precisely, and restricted it to one species of stones. We use the word in the sense assigned by him.

Shorl is found abundantly in mountains, either massive or crystallized, in three or nine sided prisms, often terminated by three sided summits. The sides of the crystals are longitudinally streaked. Its texture is foliated. Its fracture conchoidal. Lustre 2. Opaque. Hardness 10. Sp. gr. 2.92 to 3.212. Colour black. Streak grey. It does not become electric by heat. When heated to redness, its colour becomes brownish red; and at 127° Wedgewood, it is converted into a brownish compact enamel †. According to Wiegand,

† *Ibid.* i.
266.

it is composed of
41.25 alumina,
34.16 silica,
20.00 iron,
5.41 manganese.

§ Crell's
Beiträge, I.
Bandes. 4.
Stück, P.
21.

47
Granatite.

¶ Fig. 10.
* Romé de
Lille, ii.
435.

100.82 §
SPECIES 5. Granatite.

Staurolite of Haüy—*Pierre de Croix* of De Lisle—*Staurolite* of Lametherie.

We have adopted from Mr Vauquelin the term *granatite* to denote this stone, because all the other names are ambiguous, having been applied to another mineral possessed of very different properties.

Granatite is found in Galicia in Spain, and Brittany in France. It is always crystallized in a very peculiar form; two six-sided prisms intersect each other, either at right angles or obliquely ¶. Hence the name *crossstone*, by which it was known in France and Spain *. Mr Haüy has proved, in a very ingenious manner, that the primitive form of the granatite is a rectangular prism, whose bases are rhombs, with angles of 129½° and 50½°; and that the height of the prism is to the greater diagonal of a rhomb as 1 to 6; and that its integrant molecules are triangular prisms, similar to what would be obtained by cutting the primitive crystal in two, by a plane passing vertically through the shorter

diagonal of the rhomboidal base. From this structure he has demonstrated the law of the formation of the cruciform varieties †. The colour of granatite is greyish or reddish brown.

Simple
Stones.
† *Ann. de
Chim.* vi.
142.

According to the analysis of Vauquelin, it is composed of
47.06 alumina,
30.59 silica,
15.30 oxide of iron,
3.00 lime.

95.95 †.
GENUS VI. 2. SAI.

† *Ibid.* xxx.
106.

SPECIES 4. Tourmaline (z).

48
G. VI. 2.
SAI.

This stone was first made known in Europe by specimens brought from Ceylon; but it is now found frequently forming a part of the composition of mountains. It is either in amorphous pieces, or crystallized in three or nine sided prisms, with four-sided summits.

Its texture is foliated: Its fracture conchoidal. Internal lustre 2 to 3. Transparency 3 to 4; sometimes only 2 (A). Causes only single refraction §. Hardness 9 to 11. Sp. gr. 3.05 to 3.155. Colour brown, often so dark that the stone appears black; the brown has also sometimes a tint of green, blue, red, or yellow.

§ Haüy,
*Four. de
Min.* No
xxviii. 265.

When heated to 200° Fahrenheit, it becomes electric; one of the summits of the crystal negatively, the other positively ¶. It reddens when heated; and is fusible *per se* with intumescence into a white or grey enamel.

¶ *Æpinus.*

A specimen of the tourmaline of Ceylon, analysed by Vauquelin, was composed of

40 silica,
39 alumina,
12 oxide of iron,
4 lime,
2.5 oxide of manganese.

97.5 *.
SPECIES 5. Argentine felspar †.

* *Ann. de
Chim.* xxx.
105.

This stone was discovered by Mr Dodun in the black mountains of Languedoc. It is either amorphous, or crystallized in rhomboidal tables, or six or eight sided prisms. Its texture is foliated. Fragments rectangular. Laminæ inflexible. Internal lustre 4. Transparency 2. Colour white; two opposite faces of the crystals are silver white, two others dead white. Hardness of the silvery laminæ 6, of the rest 9. Brittle. Sp. gr. 2.5. When the flame of the blow-pipe is directed against the edges of the crystal (stuck upon glass), it easily melts into a clear compact glass; but when the flame is directed against the faces, they preserve their lustre, and the edges alone slowly melt.

49
Argentine
felspar.
† *Kirwan*,
i. 327.

According to the analysis of Dodun, it is composed

of
46 silica,
36 alumina,
16 oxide of iron,

98

When this stone is exposed to the atmosphere, it is apt

(z) Kirw. I. 271.—Berg. II. 118. and V. 402.—Gerhard. *Mem. Berlin*, 1777. p. 14.—Haüy *Mem. Par.* 1784, 270.—Wilson *Phil. Trans.* XLI. 308.—Æpinus, *Recueil sur la Tourmaline*. See also *La Porterie. Le Saphir, l'Oeil de Chat, et la Tourmaline de Ceylon démasqués*.
(A) And when black only 1.

Earths and
Stones.

apt to decay : Its surface becomes iridescent, and at last changes to ochre yellow : Its specific gravity is 2.3 or 2.212 ; and when breathed upon, it gives out an earthy smell.

50

Mica.

SPECIES 6. MICA *.

* Kirw. i. This stone forms an essential part of many mountains, and has been long known under the names of *glacies marie* and *Muscovy glass*. It consists of a great number of thin laminae adhering to each other, sometimes of a very large size. Specimens have been found in Siberia nearly $2\frac{1}{2}$ yards square (B).

† Fig. 11. It is sometimes crystallized : Its primitive form is a rectangular prism, whose bases are rhombs, with angles of 120° and 60° † : Its integrant molecule has the same form. Sometimes it occurs in rectangular prisms, whose bases also are rectangles, and sometimes also in a short six-sided prisms ‡ ; but is much more frequently in plates or scales of no determinate figure or size §.

‡ Fig. 12. Its texture is foliated. Its fragments flat. The lamellæ flexible, and somewhat elastic. Lustre metallic, from 3 to 4. Transparency of the laminae 3 or 4, sometimes only 2 (c). Hardness 6. Very tough. Often absorbs water. Sp. gr. from 2.6546 to 2.9342. Feels smooth, but not greasy. Powder feels greasy. Colour, when purest, silver white or grey ; but it occurs also yellow, greenish, reddish, brown, and black. Mica is fusible by the blow-pipe into a white, grey, green, or black, enamel ; and this last is attracted by the magnet (D). Spanish wax rubbed by it becomes negatively electric ¶.

¶ Ibid.

A specimen of mica, analysed by Vanquelin, contained

50.00 silica,
35.00 alumina,
7.00 oxide of iron.
1.35 magnesia,
1.33 lime,
94.68 *.

* Ibid. 302.

Mica has long been employed as a substitute for glass. A great quantity of it is said to be used in the Russian marine for panes to the cabin windows of ships ; it is preferred, because it is not so liable as glass to be broken by the agitation of the ship.

51
Talc.

SPECIES 7. Talc †.

* Kirw. i. This stone has a very strong resemblance to mica, and was long considered as a mere variety of that mineral. It occurs sometimes in small loose scales, and sometimes in an indurated form ; but it has not hitherto been found crystallized.

† Haüy, Jour. de Min. N° xxviii. 291. Its texture is foliated. The lamellæ are flexible, but not elastic. Its lustre is from 2 to 4. Transparency from 2 to 4. Hardness 4 to 6. Sp. gr. when indurated, from 2.7 to 2.8. Feels greasy. Colour most commonly whitish or greenish. Spanish wax rubbed with it becomes positively electric ‡.

Variety 1. Scaly talc.

Talcite of Kirwan.

This variety occurs under the form of small scales,

scarcely cohering. Lustre 3 to 4. Very light. Adheres to the fingers. When rubbed upon the skin, it gives it a gloss. Colour white, with a shade of red or green ; sometimes leek green.

Variety 2. Common talc.

Venetian talc.

This variety often occurs in oblong nodules. Lustre, nearly metallic, 4. Transparency 2 to 3 ; when very thin 4. Hardness 4 to 5. Colour white, with a shade of green or red ; or apple green, verging towards silver white. By transmitted light green.

Variety 3. Shistose talc.

Its structure is flaty. Fracture hackly and long splintery. Easily crumbles when rubbed in the fracture. External lustre 2 to 3 ; internal, 1 ; but sometimes, in certain positions, 3. Colour grey, with a shade of white, green or blue. Becomes white and scaly when exposed to the air.

A specimen of common talc, analysed by Mr Chenevix, contained

48.0 silica,
37.0 alumina,
6.0 oxide of iron,
1.5 magnesia,
1.5 lime,
5.0 water,

99.0 §.

SPECIES 8. Basaltine ¶.

Basaltic hornblende of Werner—*Asinote* of Haüy—*Zillerite* of Lametherie—*Short prismatique hexagone* of Saussure.

This stone is found commonly in basaltic rocks ; hence its name, which we have borrowed from Mr Kirwan. It is crystallized, either in rhomboidal prisms, or six or eight sided prisms, terminated by three-sided pyramids. Its texture is foliated. Its fracture uneven. Lustre 3. Transparency, when in very thin plates, 1. Hardness from 9 to 10. Sp. gr. 3.333. Colour black, dark green, or yellowish green. Streak white. Transmits a reddish yellow light. Before the blow-pipe, it melts into a greyish coloured enamel, with a tint of yellow *. A specimen, seemingly of this stone, analysed by Berg-

man, contained 58 silica,
27 alumina,
9 iron,
4 lime,
1 magnesia,

99 †.

SPECIES 9. Hornblende ‡.

Amphibole of Haüy (E).

This stone enters into the composition of various mountains. Its texture is very conspicuously foliated. Fracture conchoidal. Fragments often rhomboidal. Lustre 2. Opaque. Hardness 5 to 9. Tough. Sp. gr. 2.922 to 3.41. Colour black, blackish green, olive green,

Simple
Stones.§ Ann. de
Chim. xxviii.
200.52
Basaltine.
¶ Kirw. i.
219.* Le Lievre,
Jour. de
Min. N°
xxviii. 269.† Berg. iii.
207.53
Horn-
blende.
‡ Kirw. i.
213.

(B) *Hist. General de Voyages*, T. XVIII. 272, quoted by Haüy *Jour. de Min.* N° XXVIII. 299.

(C) Black mica is often nearly opaque.

(D) Haüy, *ibid.* p. 295. Bergman, however, found pure mica infusible *per se* ; and this has been the case with all the specimens of Muscovy glass which we have tried.

(E) We suspect, that under this name Mr Haüy comprehends *borl* also.

Earths and
Stones.* Haüy,
four. de
Min. N°
xxviii. 267.† Beob. der
Berlin, 5.
Band. 31754
Resplen-
dent horn-
blende.† Kirw. i.
221.§ Bergbau-
kunde, i. Band.
p. 92.55.
Obsidian.
* Kirw. i.
204.† Berg. iii.
204.56
Petrilite.
† Kirw. i.
325.57
Felsite
† Kirw. i.
326.

green, or leek green. Streak greenish. It neither be-
comes electric by friction nor heat*. Before the blow-
pipe it melts into a black glass. A specimen of black
hornblende, analysed by Mr Hermann, was composed of

37 silica,
27 alumina,
25 iron,
5 lime,
3 magnesia.

97†

SPECIES 10. Resplendent Hornblende.

There are two minerals which Werner considers as
varieties of hornblende, and Mr. Kirwan as constituting
a distinct species. These till future analyses decide the
point, we shall place here under the name of resplendent
hornblende, the name given them by Mr Kirwan; and
we shall describe them separately.

Variety 1. Labrador hornblende.

Texture, curved foliated. Lustre, in some posi-
tions, 0; in others metallic, and from 3 to 4. Opaque.
Hardness 8 to 9. Sp. gr. from 3.35 to 3.434. Co-
lour, in most positions, greyish black; in others, it re-
flects a strong iron grey, sometimes mixed with copper
red.

Variety 2. Shiller spar †.

Texture foliated. Lustre metallic, 4. Transparen-
cy, in thin pieces, 1. Hardness 8 to 9. Sp. gr. 2.882.
Colour green, often with a shade of yellow; also golden
yellow. In some positions it reflects white, grey, or
yellow. At 141° Wedgewood, hardened into a porce-
lain mass. A specimen, analysed by Gmelin, was com-
posed of

43.7 silica,
17.9 alumina,
23.7 iron,
11.2 magnesia.

96.5 †

It has been found in the Hartz, stuck in a serpen-
tine rock.

SPECIES 11. Obsidian*.

Iceland agate.

This stone is found either in detached masses, or form-
ing a part of the rocks which compose many mountains.
It is usually invested with a grey or opaque crust. Its
fracture is conchoidal. Its internal lustre 3. Trans-
parency 1. Hardness 10. Sp. gr. 2.348. Colour
black or greyish black; when in very thin pieces, green.
It melts into an opaque grey mass. According to Berg-
man, it is composed of

69 silica,
22 alumina,
9 iron.

100†

SPECIES 12. Petrilite †.

Cubic felspar.

This stone is found in the mass of mountains. It is
amorphous. Texture foliated. Fracture splintery. Frag-
ments cubic, or inclining to that form; their faces un-
polished. Lustre 2. Transparency partly 2, partly 1.
Hardness 9. Sp. gr. 3.081. Colour reddish brown.
Does not melt at 160° Wedgewood.

SPECIES 13. Felsite †.

Compag felspar.

This stone also forms a part of many mountains, and
SUPPL. VOL. II. Part I.

is amorphous. Texture somewhat foliated. Fracture
uneven, approaching to the splintery. Lustre 1. Trans-
parency scarce 1. Hardness 9. Colour azure blue,
and sometimes brown and green. Streak white. Be-
fore the blow-pipe, whitens and becomes rifted; but is
infusible *per se*.

GENUS VII. SAP.

SPECIES 1. Felspar*.

This stone forms the principal part of many of the
highest mountains. It is commonly crystallized. Its
primitive form, according to De Lisle, is a rectangular
prism, whose bases are rhombs, with angles of 65° and
115†°. Sometimes the edges of the prism are wanting,
and faces in their place; and sometimes this is the case
also with the acute angles of the rhomb. For a de-
scription and figure of these, and other varieties, we re-
fer the reader to *Romé de Lisle*†, *Mr Haüy*‡, and *Mr*
*Pini**.

Its texture is foliated. Its cross fracture uneven.
Fragments rhomboidal, and commonly smooth and po-
lished on four sides. Lustre of the polished faces often
3. Transparency from 3 to 1. Hardness 9 to 10. Sp.
gr. from 2.437 to 2.7. Gives a peculiar odour when
rubbed. It is made electric with great difficulty by
friction. Fusible *per se* into a more or less transparent
glass. When crystallized, it decrepitates before the
blow-pipe.

Variety 1. Pure Felspar.

Moon stone—Adularia.

This is the purest felspar hitherto found. It occurs
in Ceylon and Switzerland; and was first mentioned by
Mr Sage. Lustre nearly 3. Transparency 2 to 3.
Hardness 10. Sp. gr. 2.559. Colour white; some-
times with a shade of yellow, green, or red. Its surface
is sometimes iridescent.

Variety 2. Common Felspar.

Lustre of the cross fracture 0; of the fracture, in the
direction of the laminae, from 3 to 1. Transparency 2
to 1. Colour most commonly flesh red; but often bluish
grey, yellowish white, milk white, brownish yellow; and
sometimes blue, olive green, and even black.

Variety 3. Labrador felspar.

This variety was discovered on the coast of Labra-
dore by Mr Wolfe; and since that time it has been
found in Europe. Lustre 2 to 3. Transparency from
1 to 3. Sp. gr. from 2.67 to 2.6925. Colour grey.
In certain positions, spots of it reflect a blue, purple,
red, or green colour.

Variety 4. Continuous felspar.

This variety most probably belongs to a different spe-
cies; but as it has not hitherto been analysed, we did
not think ourselves at liberty to alter its place.

It is found in large masses. Texture earthy. Frac-
ture uneven, sometimes splintery. Lustre 0. Trans-
parency 1. Hardness 10. Sp. gr. 2.609. Colour
reddish grey, reddish yellow, flesh red.

A specimen of green felspar from Siberia, analysed
by Vauquelin, contained

62.83 silica,
17.02 alumina,
16.00 potash,
3.00 lime,
1.00 oxide of iron.

99.85†

D d

Simple
Stones.58
G. VII. SAP.
Felspar.* Kirw. i.
316. and
four. de
Phys. pas-
fin.† Fig. 13.
and 14.† Crystall.
ii. 401.§ Mem.
Pur. 1784,
p. 273.* Sur de
Nouvelle
Cristallisa-
tion, &c. 8.† Ann. de
Chim. xxx.

SPECIES 106.

Earths and
Stones.

SPECIES 2. Lepidolite (F).

Lilalite.

This stone appears to have been first observed by the Abbé Poda, and to have been first described by De *Cress's Ann.* Born *. Hitherto it has only been found in Moravia in Germany, and Sudermania in Sweden †. There it is mixed with granite in large amorphous masses. It is composed of thin plates, easily separated, and not unlike those of mica ‡. Lustre, pearly 3. Transparency between 1 and 2. Hardness 4 to 5. Not easily pulverised §. Sp. gr. from 2.816 * to 2.8549 †. Colour of the mass, violet blue; of the thin plates, silvery white. Powder white, with a tint of red ‡. Before the blow-pipe, it froths, and melts easily into a white semitransparent enamel, full of bubbles. Dissolves in borax with effervescence, and communicates no colour to it §. Effervesces slightly with soda, and melts into a mass spotted with red. With microcosmic salt, it gives a pearl coloured globule *.

This stone was first called lilalite from its colour, that of the *lily*. Klaproth, who discovered its component parts, gave it the name of *lepidolite* (G).

It is composed of

53 silica,
20 alumina,
18 potash,
5 fluat of lime,
3 oxide of manganese,
1 oxide of iron.

100 †

SPECIES 3. Leucite †

Vesuvian of Kirwan—*White Garnet* of Vesuvius.

This stone is usually found in volcanic productions, and is very abundant in the neighbourhood of Vesuvius. It is always crystallized. The primitive form of its crystals is either a cube or a rhomboidal dodecahedron, and its integrant molecules are tetrahedrons; but the varieties hitherto observed are all polyhedrons: The most common has a spheroidal figure, and is bounded by 24 equal and similar trapezoids §; sometimes the faces are 12, 18, 36, 54, and triangular, pentagonal, &c. For a description and figure of several of these, we refer the reader to Mr Haüy *. The crystals vary from the size of a pin-head to that of an inch.

The texture of the leucite is foliated. Its fracture somewhat conchoidal. Lustre 3; when in a state of decomposition 0. Transparency 3 to 2; when decomposing 0. Hardness 8 to 10; when decomposing 5 to 6. Sp. gr. 2.4648. Colour white, or greyish white (H). Its powder causes syrup of violets to assume a green colour †.

It is composed, as Klaproth has shewn, of

54 silica,
23 alumina,
22 potash.

99 (1)

It was by analysing this stone that Klaproth discovered the presence of potash in the mineral kingdom; which is not the least important of the numerous discoveries of that accurate and illustrious chemist.

Leucite is found sometimes in rocks which have never been exposed to volcanic fire; and Mr. Dolomieu has rendered it probable, from the substances in which it is found, that the leucite of volcanoes has not been formed by volcanic fire, but that it existed previously in the rocks upon which the volcanoes have acted, and that it was thrown out unaltered in fragments of these rocks ‡.

GENUS VIII. SAG.

SPECIES 1. Emerald (K).

This stone has hitherto been only found crystallized. The primitive form of its crystals is a regular six-sided prism; and the form of its integrant molecules is a triangular prism, whose sides are squares, and bases equilateral triangles §. The most common variety of its crystals is the regular six-sided prism, sometimes with the edges of the prism or of the bases, or the solid angles, 72 or both wanting *, and small faces in their place †. The sides of the prism are generally channelled.

Its texture is foliated. Its fracture conchoidal. Lustre usually from 3 to 4. Transparency from 2 to 4. Causes a double refraction. Hardness 12. Sp. gr. 2.65 to 2.775. Colour green. Becomes electric by friction, but not by heat. Its powder does not phosphoresce when thrown on a hot iron ‡. At 150° Wedgewood it melts into an opaque coloured mass. According to Dolomieu, it is fusible *per se* by the blow-pipe *.

This mineral was formerly subdivided into two distinct species, the *emerald*, and *beryl* or *aqua marina*. Haüy demonstrated, that the emerald and beryl corresponded exactly in their structure and properties, and Vauquelin found that they were composed of the same ingredients; henceforth, therefore, they must be considered as varieties of the same species.

The variety formerly called *emerald* varies in colour from the pale to the perfect green. When heated to 120° Wedgewood, it becomes *blue*, but recovers its colour when cold. A specimen, analysed by Vauquelin, was composed of

64.60 silica,
14.00 alumina,
13.00 glucina,
3.50 oxide of chromium,
2.56 lime,
2.00 moisture or other volatile ingredient.

99.66 †

The *beryl* is of a greyish green colour, and sometimes blue, yellow, and even white: sometimes different colours appear in the same stone ‡. It is found in Ceylon, different parts of India, Brazil, and especially in Siberia and Tartary, where its crystals are sometimes a foot long §. *Ibid.*

Simple
Stones.

† *Four. de Min. N°*
xxxix. 177.

† *Four. de Min. N°*
xxxix. 177.

† *Four. de Min. N°*
xxxix. 177.

† *Four. de Min. N°*
xxxix. 177.

† *Four. de Min. N°*
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† *Four. de Min. N°*
xxxix. 177.

† *Four. de Min. N°*
xxxix. 177.

† *Four. de Min. N°*
xxxix. 177.

(F) Kirw. I. 208.—*Karsten. Beob. der Berlin*, 5 Band. 71.—*Klaproth Beiträge*, I. 279. and II. 191.

(G) That is, *scale stone*, or stone composed of scales: From *λεπίς* the scale of a fish, and *λίθος* a stone.

(H) Hence the name leucite, from *λευκος*, white.

(I) See *Four. de Min. N°* XXVII. 164. and 201. and *Klaproth's Beiträge*, II. 39.

(K) Kir. I. 247. and 248.—*Dolomieu. Magazin Encyclopédique*, II. 17. and 145.; and *Four de Min. N°* XVIII. 19.—*Klaproth Beiträge*, II.

Order I.

MINERALOGY.

211

Earths and long. A specimen of beryl, analysed by Vauquelin, contained

69	silica,
13	alumina,
16	glucina,
1.5	oxide of iron.

* Ann. de Chim. xxviii. 168. It was by analysing this stone that Vauquelin discovered the earth which he called *glucina*.

62
G. IX. SAB
Staurolite.
† Kirw. i. 282. *Andreolite* of Lametherie and Haüy—*Hyacinthe blanche cruciforme*, var. g. of Romé de Lisle.

† Fig. 17. This stone has been found at Andreasberg in the Hartz. It is crystallized, and the form of its crystals has induced mineralogists to give it the name of *cross-stone*. Its crystals † are two four-sided flattened prisms, terminated by four-sided pyramids, intersecting each other at right angles: the plane of intersection passing longitudinally through the prisms (L).

Its texture is foliated. Its lustre waxy, 2. Transparency from 1 to 3. Hardness 9. Brittle. Sp. gr. 2.355 to 2.361. Colour milk white. When heated slowly, it loses 0.15 or 0.16 parts of its weight, and falls into powder. It effervesces with borax and microcosmic salt, and is reduced to a greenish opaque mass. With soda it melts into a frothy white enamel. When its powder is thrown on a hot coal, it emits a greenish yellow light †.

§ Haüy, Jour. de Min. N° xxviii. 280. A specimen analysed by Westrum was composed of

44	silica,
20	alumina,
20	barytes,
16	water.

100

Klaproth found the same ingredients, and nearly in the same proportions *.

* Beiträge, ii. 80. A variety of staurolite has been found only once, which has the following peculiarities.

Its lustre is pearly, 2. Sp. gr. 2.361. Colour brownish grey. With soda it melts into a purplish and yellowish frothy enamel. It is composed, according to Westrum, of

47.5	silica,
12.0	alumina,
20.0	barytes,
16.0	water,
4.5	oxides of iron and manganese.

100.0

63
G. X. ASL.
Chrysoberyl.
† Kirw. i. 261. *Oriental chrysolite* of jewellers—*Cymophane* of Haüy.

Hitherto this stone has been found only in Brazil, the island of Ceylon, and as some affirm near Nortschink in Siberia. Werner first made it a distinct species, and gave it the name which we have adopted. It is usually found in round masses about the size of a pea, but it is sometimes also crystallized. The primitive form of its crystals is a four-sided rectangular prism, whose height

is to its breadth as $\sqrt{3}$ to 1, and to its thickness as $\sqrt{2}$ to 1*. The only variety hitherto observed is an eight-sided prism, terminated by six-sided summits†. Two of the faces of the prism are hexagons, two are rectangles, and four trapeziums; two faces of the summits are rectangles, and the other four trapeziums. Sometimes two of the edges of the prism are wanting, and small faces in their place †.

† Haüy, Jour. de Min. N° xxi. 5. Its texture is foliated. Laminæ parallel to the faces of the prism. Lustre 3 to 4. Transparency 3 to 4. Causes single refraction. Hardness 12. Sp. gr. from 3.698 † to 3.7961*. Colour yellowish green, surface sparkling. It is infusible by the blow-pipe *per se*, and with soda.

A specimen of chrysoberyl, analysed by Klaproth, was composed of

71.5	alumina,
18.0	silica,
6.0	lime,
1.5	oxide of iron.

97.0 †

† Beiträge.

GENUS X. 2. SAL.
SPECIES 2. Hyalite*.

64
G. X. 2. SAL.
Hyalite.
* Kirw. i. 296.

This stone is frequently found in trap. It occurs in grains, filaments, and rhomboidal masses. Texture foliated. Fracture uneven, inclining to conchoidal. Lustre glassy (M), 2 to 3. Transparency 2 to 3; sometimes, though seldom, it is opaque. Hardness 9. Sp. gr. 2.11 †. Colour pure white. Infusible at 150° Wedgewood; but it yields to soda †. According to Mr Link, it is † composed of

57	silica,
18	alumina,
15	lime.

90 and a very little iron †.

§ Crelf's Annals, 1790, 2 Band. 232

Species 3. *Ædelite**.

This stone has hitherto been found only in Sweden at Mofseberg and *Ædelfors*. From this last place Mr Kirwan, who first made it a distinct species, has given it the name which we have adopted. It was first mentioned by Bergman †. Its form is tuberoso and knotty. † Opusc. vi. Texture striated; sometimes resembles quartz. Lustre from 0 to 1. Sp. gr. 2.515 after it has absorbed water †. Colour light grey, often tinged red; also yellowish brown, yellowish green, and green. Before the blow-pipe it intumesces and forms a frothy mass. Acids convert it into a jelly †. A specimen from Mofseberg, analysed by Bergman, contained

69	silica,
20	alumina,
8	lime,
3	water.

100*

A specimen from *Ædelfors* yielded to the same chemist

62	silica,
18	alumina,
17	lime,
4	water.

100 †

D d 2

GENUS

† Ibid.

(L) See Gillot, Jour. de Phys. 1793, p. 1 and 2.

(M) Hence probably the name *hyalite*, which was imposed by Werner from *υαλις*, and *λεθος*, a stone.

Earths and
Stones.66
G. X. 3.
SAWL.
Zeolite.* Haüy,
Jour. de
Min. N°
xiv. 86.† Haüy, *ibid*
N° xxviii.
276.† *Ibid*. N°
xliv. 576.67
Stilbite.* Haüy,
Jour. de
Min. N°
xiv. 86.† Haüy, *ibid*
N° xxviii.
276.† Vauquelin,
ibid. N°
xxxix. 261.

GENUS X. 3. SAWL.

SPECIES 4. Zeolite (N).

This stone was first described by Cronstedt in the Stockholm Transactions for 1756. It is found sometimes amorphous and sometimes crystallized. The primitive form of its crystals is a rectangular prism, whose bases are squares. The most common variety is a long four-sided prism, terminated by low four-sided pyramids*.

Its texture is striated or fibrous. Its lustre is silky, from 3 to 1. Transparency from 2 to 4; sometimes 1. Hardness 6 to 8; sometimes only 4. Absorbs water. Sp. gr. 2.07 to 2.3. Colour white, often with a shade of red or yellow; sometimes brick red, green, blue. When heated, it becomes electric like the tourmaline †. Before the blow-pipe it froths (o), emits a phosphorescent light, and melts into a white semitransparent enamel, too soft to cut glass, and soluble in acids. In acids it dissolves slowly and partially without effervescence; and at last, unless the quantity of liquid be too great, it is converted into a jelly.

A specimen of zeolite (P), analysed by Vauquelin,

53.00 silica,
27.00 alumina,
9.46 lime,
10.00 water.

99.46 †.

SPECIES 5. Stilbite.

This stone was first formed into a distinct species by Mr Haüy. Formerly it was considered as a variety of zeolite.

The primitive form of its crystals is a rectangular prism, whose bases are rectangles. It crystallizes sometimes in dodecahedrons, consisting of a four-sided prism with hexagonal faces, terminated by four-sided summits, whose faces are oblique parallelograms; sometimes in six-sided prisms, two of whose solid angles are wanting, and a small triangular face in their place*.

Its texture is foliated. The laminae are easily separated from each other; and are somewhat flexible. Lustre pearly, 2 or 3 (Q). Hardness inferior to that of zeolite, which scratches stilbite. Brittle. Sp. gr. 2.500†. Colour pearl white. Powder bright white, sometimes with a shade of red. This powder, when exposed to the air, cakes and adheres as if it had absorbed water. It causes syrup of violets to assume a green colour. When stilbite is heated in a porcelain crucible, it swells up and assumes the colour and semitransparency of baked porcelain. By this process it loses 0.185 of its weight. Before the blow-pipe it froths like borax, and then melts into an opaque white-coloured en-

According to the analysis of Vauquelin, it is composed of

52.0 silica,
17.5 alumina,
9.0 lime,
18.5 water.

97.0 *

SPECIES 6. Analcime.

This stone, which was discovered by Mr Dolomieu, is found crystallized in the cavities of lava. It was first made a distinct species by Mr Haüy. Mineralogists had formerly confounded it with zeolite.

The primitive form of its crystals is a cube. It is sometimes found crystallized in cubes, whose solid angles are wanting, and three small triangular faces in place of each; sometimes in polyhedrons with 24 faces. It is usually somewhat transparent. Hardness about 8; scratches glass slightly. Sp. gr. above 2. When rubbed, it acquires only a small degree of electricity, and with difficulty (s). Before the blow-pipe it melts without frothing, into a white semitransparent glass†.

GENUS X. 4. SLA.

SPECIES 7. Lazulite †.

This stone, which is found chiefly in the northern parts of Asia, has been long known to mineralogists by the name of *lapis lazuli*. This term has been contracted into *lazulite* by Mr Haüy; an alteration which was certainly proper, and which therefore we have adopted.

Lazulite is always amorphous. Its texture is earthy. Its fracture uneven. Lustre o. Opaque, or nearly so. Hardness 8 to 9. Sp. gr. 2.76 to 2.945*. Colour blue (s); often spotted white from specks of quartz, and yellow from particles of pyrites.

It retains its colour at 100° Wedgewood; in a higher heat it intumesces, and melts into a yellowish black mass. With acids it effervesces a little, and if previously calcined, forms with them a jelly.

Margraff published an analysis of lazulite in the Berlin Memoirs for 1758. His analysis has since been confirmed by Klaproth, who found a specimen of it to contain

46.0 silica,
14.5 alumina,
28.0 carbonat of lime,
6.5 sulphat of lime,
3.0 oxide of iron,
2.0 water.

100.0 †

GENUS XI. SALL.

SPECIES 1. Garnet (T).

This stone is found abundantly in many mountains. It is usually crystallized. The primitive form of its crystals

Simple

Stones.

* *Ibid*. 164.

68

Analcime.

† Haüy,

Jour. de

Min. N°xiv.

86. and

xxviii. 278.

69

G.X. 4. SLA.

Lazulite.

† Kirw. i.

283.

69

G.X. 4. SLA.

Lazulite.

† Kirw. i.

283.

69

G.X. 4. SLA.

Lazulite.

† Kirw. i.

283.

69

G.X. 4. SLA.

Lazulite.

† Kirw. i.

283.

69

G.X. 4. SLA.

Lazulite.

† Kirw. i.

283.

69

G.X. 4. SLA.

Lazulite.

† Kirw. i.

283.

69

G.X. 4. SLA.

Lazulite.

† Kirw. i.

283.

69

G.X. 4. SLA.

Lazulite.

† Kirw. i.

283.

69

G.X. 4. SLA.

Lazulite.

† Kirw. i.

283.

69

G.X. 4. SLA.

Lazulite.

† Kirw. i.

283.

69

G.X. 4. SLA.

Lazulite.

† Kirw. i.

283.

Earth's and crystals is a dodecahedron whose sides are rhombs, with angles of $78^{\circ} 31' 44''$, and $120^{\circ} 28' 16''$. The inclination of the rhombs to each other is 120° . This dodecahedron may be considered as a four-sided prism, terminated by four-sided pyramids*. It is divisible into four parallelepipeds, whose sides are rhombs; and each of these may be divided into four tetrahedrons, whose sides are isosceles triangles, equal and similar to either of the halves into which the rhomboidal faces of the dodecahedron are divided by their shorter diagonal. The

* Fig. 20. De Lisle, ii. 322. and Haüy, Ann. de Chim. xvii. 305. integral molecules of garnet are similar tetrahedrons†. Sometimes the edges of the dodecahedrons are wanting, and small faces in their place; and sometimes garnet is crystallized in polyhedrons, having 24 trapezoidal faces. For a description and figure of these, and other varieties of garnet, we refer to Romé de Lisle and Haüy†.

† Haüy, *ibid.* 306. The texture of garnet, as Bergman first shewed, is foliated §. Its fracture commonly conchoidal. Internal lustre from 4 to 2. Transparency from 2 to 4; sometimes only 1 or 0. Causes single refraction ||. Hardness from 10 to 14. Sp. gr. 3.75 to 4.188. Colour usually red. Often attracted by the magnet. Fusible *per se* by the blow-pipe.

§ Opusc. ii. 9. || Haüy, *Jour. de Min.* N^o xxviii. 260. Variety 1. Oriental garnet (v).

Internal lustre 3 to 4. Transparency 4. Hardness 13 to 14. Sp. gr. 4 to 4.188. Colour deep red, inclining to violet (x).

Variety 2: Common garnet.

Fracture uneven, inclining to the conchoidal. Internal lustre 2 to 3. Transparency from 3 to 0. Hardness 10 to 11; sometimes only 9. Sp. gr. 3.75 to 4. Colour commonly deep red, inclining to violet; sometimes verging towards black or olive; sometimes leek green, brown, yellow.

Variety 3. Amorphous garnet.

Structure stony. Lustre 2. Transparency 2 to 1. Hardness 11 to 12. Sp. gr. 3.89. Colour brownish or blackish red. Found in Sweden, Switzerland, and the East Indies.

A specimen of oriental garnet, analysed by Klaproth, contained

35.75 silica,
27.25 alumina,
36.00 oxide of iron,
0.25 oxide of manganese.
99.25*

* Beitrüge, ii. 26.

A specimen of red garnet, analysed by Vauquelin, contained

52.0 silica,
20.0 alumina,
17.0 oxide of iron,
7.7 lime.

† *Jour. de Min.* N^o xlv. 573.

A specimen of black garnet yielded to the same chemist

43 silica,
16 alumina,
20 lime,
16 oxide of iron,
4 moisture.

† *Ibid.* 573.

99 †

Mr Klaproth found a specimen of Bohemian garnet, composed of

40.00 silica,
28.50 alumina,
16.50 oxide of iron,
10.00 magnesia,
3.50 lime,
.25 oxide of manganese.

98.75*

SPECIES 2. Thumerstone †.

Yanulite of Lamatherie—Axinite of Haüy.

This stone was first described by Mr Schreber, who found it near Balme d'Auris in Dauphiné, and gave it the name of *shorl violé* †. It was afterwards found near Thum in Saxony, in consequence of which Werner called it *thumerstone*.

It is sometimes amorphous; but more commonly crystallized. The primitive form of its crystals is a rectangular prism, whose bases are parallelograms with angles of $101^{\circ} 32'$ and $78^{\circ} 28'$ §. The most usual variety is a flat rhomboidal parallelepiped, with two of its opposite edges wanting, and a small face in place of each ||. The faces of the parallelepiped are generally streaked longitudinally ¶.

The texture of thumerstone is foliated. Its fracture conchoidal. Lustre 2. Transparency, when crystallized, 3 to 4; when amorphous, 2 to 1. Causes simple refraction*. Hardness 10 to 9. Sp. gr. 3.2956. Colour clove brown; sometimes inclining to red, green, grey, violet, or black. Before the blow-pipe it froths like zeolite, and melts into a hard black enamel. With borax it exhibits the same phenomena, or even when the stone is simply heated at the end of a pincer †.

A specimen of thumerstone, analysed by Klaproth, contained

52.7 silica,
25.6 alumina,
9.4 lime,
9.6 oxide of iron with a trace of manganese.

97.3 †

A specimen, analysed by Vauquelin, contained

44 silica,
18 alumina,
19 lime,
14 oxide of iron,
4 oxide of manganese.

99 §

SPECIES 3. Prehnite (y).

Though this stone had been mentioned by Sage ||, Prehnite, Romé de Lisle ¶, and other mineralogists, Werner was the first who properly distinguished it from other minerals, and made it a distinct species. The specimen which he examined was brought from the Cape of Good Hope by Colonel Prehn; hence the name *prehnite*, by which he distinguished it. It was found near Dunbarton by Mr Grotche*; and since that time it has been observed in other parts of Scotland.

It

(v) This seems to be the *carbuncle* (καρβυνκλις) of Theophrastus, and the *carbunculus garamanticus* of other ancient writers. See Hill's *Theophrastus*, περι λίθων, p. 74. and 77.

(x) Hence, according to many, the name *garnet* (in Latin *granatus*), from the resemblance of the stone in colour to the blossoms of the pomegranate.

(y) Kirw. I. 274.—Hassensfratz, *Jour. de Phys.* XXXII. 81.—Sage, *ibid.* XXXIV. 446.—Klaproth, *Beob. der Berlin*, 2 Band. 211. And *Ann. de Chim.* I. 201.

Simple Stones.

* Beitrüge, ii. 21.

† Thumerstone.

‡ Kirw. i.

§ Pel-

letier, *Journ.*

de Phys.

xxvi. 66.

† De Lisle,

ii. 353.

§ Haüy,

Jour. de

Min. N^o

xxviii. 264.

¶ Fig. 21.

† De Lisle,

ibid.

* Haüy, *ibid.*

† Vauquelin,

Jour. de

Min. N^o

xxiii. 1.

‡ Beitrüge,

ii. 126.

§ *Jour. de*

Min. *ibid.*

72

Prehnite,

† *Miner.* i.

232.

¶ *Crystallog.*

ii. 275.

* *Ann. de*

Chim. 2 13

Earths and
Stones

It is both amorphous and crystallized. The crystals are in groups, and confused; they seem to be four-sided prisms with dihedral summits*. Sometimes they are irregular six-sided plates, and sometimes flat rhomboidal parallelopipeds.

Its texture is foliated. Fracture uneven. Internal lustre pearly, scarcely 2. Transparency 3 to 2. Hardness 9 to 10. Brittle. Sp. gr. 2.6969†. Colour apple green, or greenish grey. Before the blow-pipe it froths more violently than zeolite, and melts into a brown enamel. A specimen of prehnite, analysed by Klaproth, was composed of

43.83 silica,
30.33 alumina,
18.33 lime,
5.66 oxide of iron,
1.16 air and water.

† Ann. de
Chim. i.
208.

Whereas Mr Hassenfratz found in another specimen

99.31 ‡
50.0 silica,
20.4 alumina,
23.3 lime,
4.9 iron,
.9 water,
.5 magnesia.

§ Ibid. and
Jour. de
Phys. N°
xxxii. 81.

100.0 §

SPECIES 4. Thallite.

Green *Isorl* of Dauphiné of De Lisle||.—*Delphinite* of Saussure.

Thallite.
|| *Crystallog.*
II. 401.

This stone is found in the fissures of mountains; and hitherto only in Dauphiné and on Chamouni in the Alps.

It is sometimes amorphous, and sometimes crystallized. The primitive form of its crystals is a rectangular prism, whose bases are rhombs with angles of 114° 37', and 65° 23' ¶. The most usual variety is an elongated four-sided prism (often flattened), terminated by four-sided incomplete pyramids*; sometimes it occurs in regular six-sided prisms†. The crystals are often very slender.

¶ Haüy,
Jour. de
Min. N°
xxviii. 271.
* Fig. 22.
† Romé de
Lisle, *ibid.*
and Haüy,
Jour. de
Min. N°
xxx. 415.

Its texture appears fibrous. Lustre inconsiderable. Transparency 2 to 3, sometimes 4; sometimes nearly opaque. Causes single refraction. Hardness 9 to 10. Brittle. Sp. gr. 3.4529 to 3.46. Colour dark green (z). Powder white or yellowish green, and feels dry. It does not become electric by heat. Before the blow-pipe, froths and melts into a black slag. With borax melts into a green bead ‡.

‡ Haüy, and
Descotils,
ibid.

A specimen of thallite, analysed by Mr Descotils, contained

37 silica,
27 alumina,
17 oxide of iron,
14 lime,
1.5 oxide of manganese.

§ Ibid. N°
xxx. 420.

96.5 §

GENUS XII. 1. AMS.

SPECIES 1. Cyanite*.

Sappare of Saussure.

This stone was first described by Mr Saussure the son, G. XII. AMS. who gave it the name of *sappare*†. It is commonly found in granite rocks. The primitive form of its crystals is a four-sided oblique prism, whose sides are inclined at an angle of 103°. The base forms with one side of the prism an angle of 103°; with another an angle of 77°. It is sometimes crystallized in six-sided prisms ‡.

Its texture is foliated. Laminæ long. Fragments long, splintery. Lustre pearly, 2 to 3. Transparency of the laminæ 3. Causes single refraction §. Hardness 6 to 9. Brittle. Sp. gr. from 3.092 to 3.622 ||. Feels somewhat greasy. Colour milk white, with shades of sky or prussian blue (A); sometimes bluish grey; sometimes partly bluish grey, partly yellowish or greenish grey.

Before the blow-pipe it becomes almost perfectly white; but does not melt. According to the analysis of Saussure, it is composed of

66.92 alumina,
13.25 magnesia,
12.81 silica,
5.48 iron,
1.71 lime.

100.17*

Cyanite has also been analysed by Struvius and Hermann, who agree with Saussure as to the ingredients; but differ widely from him and one another as to the proportions.

Struvius.	Hermann.
5.5 - - -	30 alumina,
30.5 - - -	39 magnesia,
51.5 - - -	23 silica,
5.0 - - -	2 iron,
4.0 - - -	3 lime.

96.5† 97‡

GENUS XII. 2. MSA.

SPECIES 2. Serpentine (B).

This stone is found in amorphous masses. Its fracture is splintery. Lustre 0. Opaque. Hardness 6 to 7. Sp. gr. 2.2645 to 2.709. Feels rather soft, almost greasy. Generally emits an earthy smell when breathed upon. Its colours are various shades of green, yellow, red, grey, brown, blue: commonly one or two colours form the ground, and one or more appear in spots or veins (c).

Before the blow-pipe it hardens and does not melt. A specimen of serpentine, analysed by Mr Chenivix, contained

34.5 magnesia,
28.0 silica,
23.0 alumina,
4.5 oxide of iron,
0.5 lime,
10.5 water.

101.0 §

GENUS § Ann. de
Chim. xxviii.
199.

(z) Hence the name *thallite* given it by Lametherie, from *θαλλος*, a green leaf.

(A) Hence the name *cyanite*, imposed by Werner.

(B) *Kirw. I. 156.*—*Margraf, Mem. Berlin, 1759, p. 3.*—*Bayen, Jour. de Phys. XIII. 46.*—*Mayer, Crell's Annals, 1789, II. 416.*

(c) Hence the name *serpentine*, given to the stone from a supposed resemblance in colours to the skin of a serpent.

Order I.

MINERALOGY.

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Earths and
Stones.

GENUS XIII. MSAL.

SPECIES 1. Potstone *.

76
G. XIII.
MSAL.
Potstone.
* Kirw. i.
155.

This stone is found in nests and beds, and is always amorphous. Its structure is often slaty. Texture undulatingly foliated. Lustre from 1 to 3. Transparency from 1 to 0; sometimes 2. Hardness 4 to 6. Brittle. Sp. gr. from 2.8531 to 3.023. Feels greasy. Sometimes absorbs water. Colour grey with a shade of green, and sometimes of red or yellow; sometimes leek green; sometimes specked with red.

Potstone is not much affected by fire; and has therefore been made into utensils for boiling water; hence its name.

According to Wiegand, the potstone of Como contains

38 magnesia,
38 silica,
7 alumina,
5 iron,
1 carbonat of lime,
1 fluoric acid.
90

77
Chlorite.
† Kirw. i.
147.

SPECIES 2. Chlorite †.

This mineral enters as an ingredient into different mountains. It is sometimes amorphous, and sometimes crystallized in oblong, four-sided, acuminate crystals.

Its texture is foliated. Its lustre from 0 to 2. Opaque. Hardness from 4 to 6; sometimes in loose scales. Colour green.

Variety 1. Farinaceous chlorite.

Composed of scales scarcely cohering, either heaped together, or investing other stones. Feels greasy. Gives an earthy smell when breathed on. Difficult to pulverise. Colour grass green; sometimes greenish brown; sometimes dark green, inclining to black. Streak white. When the powder of chlorite is exposed to the blow-pipe it becomes brown. Before the blow-pipe, farinaceous chlorite froths and melts into a dark brown glass;

† Vauquelin, with borax it forms a greenish brown glass †.

Variety 2. Indurated chlorite.

This variety is crystallized. Lustre 1. Hardness 6. Feel meagre. Colour dark green, almost black. Streak mountain green.

Variety 3. Slaty chlorite.

Structure slaty. Fragments flattened. Internal lustre 1 to 2. Hardness 5. Colour greenish grey, or dark green inclining to black. Streak mountain green.

A specimen of the first variety, analysed by Vauquelin, contained

43.3 oxide of iron,
26.0 silica,
15.5 alumina,
8.0 magnesia,
2.0 muriat of potash,
4.0 water.
98.8 g

§ Ann. de
Chim. xxx.
106.

A specimen of the same variety yielded Mr Hæp-
ner

12.92 oxide of iron,
37.50 silica,
4.17 alumina,
43.75 magnesia,
1.66 lime.

100.0 *

A specimen of the second variety, analysed by the
same chemist, contained

10.15 oxide of iron,
41.15 silica,
6.13 alumina,
39.47 magnesia,
1.50 lime,
1.50 air and water.

99.90 †

On the supposition that these analyses are accurate, the enormous difference between them is a demonstration that chlorite is not a chemical combination, but a mechanical mixture.

GENUS XIV. SLAM.

SPECIES 1. Siliceous spar (D).

This stone has been found in Transylvania. It is crystallized in 4 or 6 sided prisms, channelled transversely, and generally heaped together. Its texture is fibrous. Its lustre silky, 2. Its colours white, yellow, green, light blue. According to Bindheim, it contains

61.1 silica,
21.7 lime,
6.6 alumina,
5.0 magnesia,
1.3 oxide of iron,
3.3 water.

99.0 *

GENUS XV. SAMLI.

SPECIES 1. Argillite †.

Argillaceous schist—Common slate.

This stone constitutes a part of many mountains.

Its structure is slaty. Its texture foliated. Fracture splintery. Fragments often tabular. Lustre, most commonly silky, 2; sometimes 0. Transparency from 0 to 1. Hardness from 5 to 8. Sp. gr. from 2.67 to 2.88. Does not adhere to the tongue. Gives a clear sound when struck. Often imbibes water. Streak white or grey. Colour most commonly grey, with a shade of blue, green, or black; sometimes purplish, yellowish mountain green, brown, bluish black; sometimes striped or spotted with a darker colour than the ground.

It is composed, according to Kirwan, of silica, alumina, magnesia, lime, oxide of iron. In some varieties the

Simple
Stones.

* Saussure's
Voyages, ii.
133.

† Crell's An-
nals, 1790,
p. 56.

78
G. XIV.
SLAM
Siliceous-
spar.

* Berg. vi.
104.

79
G. XV.
SAMLI.
Argillite.
† Kirw. ii.

234

(D) Is this the tremolite of Lowitz from the lake Baikal in Siberia? If so, the name of the genus ought to be SLM; for he found it contains no alumina. According to his analysis, it was composed of

52 silica,
20 lime,
12 carbonat of lime,
12 magnesia,

96

The

Earth and the lime is wanting. Several varieties contain a considerable quantity of carbonaceous matter.

So
G. XVI.
SLACMI,
Smarag-
dite.

GENUS XVI. SLACMI.
SPECIES 1. Smaragdite.

This stone was called *smaragdite* by Mr Saussure, from some resemblance which it has to the emerald. Its texture is foliated. The laminae are inflexible. Fracture even. Hardness 7. Colour in some cases fine green, in others it has the grey colour and metallic lustre of mica: it assumes all the shades of colour between these two extremes*.

* Haüy,
Jour. de
Min. N^o
xxviii. 272.

According to the analysis of Vauquelin, it is composed of

50.0 silica,
13.0 lime,
11.0 alumina,
7.5 oxide of chromum,
6.0 magnesia,
5.5 oxide of iron,
1.5 oxide of copper.

† Ann. de
Chim. xxx.
106.

94.5 †

GENUS XVII. SM.
SPECIES 1. Kiffekil †.
Myrsen—Seafroth.

81
G. XVII.
SM.
Kiffekil.
† Kirwan's
Min. i. 144.

This mineral is dug up near Konie in Natolia, and is employed in forming the bowls of Turkish tobacco pipes. The sale of it supports a large monastery of dervises established near the place where it is dug. It is found in a large fissure six feet wide, in grey calcareous earth. The workmen assert, that it grows again in the fissure §, and puffs itself up like froth (E). This mineral, when fresh dug, is of the consistence of wax; it feels soft and greasy; its colour is yellow; its sp. gr. 1.600*: when thrown on the fire it sweats, emits a fetid vapour, becomes hard, and perfectly white.

§ Reinegg.
Philos.
Mag. iii.
165.

* Klaproth.

According to the analysis of Klaproth, it is composed of

50.50 silica,
17.25 magnesia,
25.00 water,
5.00 carbonic acid,
.50 lime.

† Beitr. ü,
ii. 172.
81
Steatites.

98.25 †

SPECIES 2. Steatites (F).

Though this mineral was noticed by the ancients, little attention was paid to it by mineralogists, till Mr Pott published his experiments on it in the Berlin Memoirs for 1747.

It is usually amorphous, but sometimes it is crystallized in six-sided prisms. Its texture is commonly earthy, but sometimes foliated. Lustre from 0 to 2. Transparency from 0 to 2. Hardness 4 to 7. Sp. gr. from 2.61 to 2.794 †. Feels greasy. Seldom adheres to the tongue. Colour usually white or grey; often with

† Briffon.

a tint of other colours; the foliated commonly green. Does not melt *per se* before the blow-pipe.

Variety 1. Semi-indurated steatites.

Texture earthy. Fracture sometimes coarse splintery. Lustre 0. Transparency 0, or scarce 1. Hardness 4 to 5. Absorbs water. Takes a polish from the nail. Colour white, with a shade of grey, yellow, or green; sometimes pure white; sometimes it contains dendritical figures; and sometimes red veins.

Variety 2. Indurated steatites.

Fracture fine splintery, often mixed with imperfectly conchoidal. External lustre 2 to 1, internal 0. Transparency 2. Often has the feel of soap. Absorbs water. Colour yellowish or greenish grey; often veined or spotted with deep yellow or red.

Variety 3. Foliated or striated steatites.

The texture of this variety is usually foliated; sometimes striated. Fragments cubiform. Lustre 3. Transparency 2 to 1. Hardness 6 to 7. Colour leek green, passing into mountain green or sulphur yellow. Streak pale greenish grey. When heated to redness, it becomes grey; and at 147° Wedgewood, it forms a grey porous porcelain mass*.

* Kirwan,

A specimen of steatites, analysed by Klaproth, contained

59.5 silica,
30.5 magnesia,
2.5 iron,
5.5 water.

98.0 †

A specimen of white steatites, analysed by Mr Che-nix, contained

60.00 silica,
28.50 magnesia,
3.00 alumina,
2.50 lime,
2.25 iron,

† Beitr. ü,
ii. 179.

96.25 †

GENUS XVIII. MSI.

SPECIES 1. Chrysolite (G).

Peridot of the French—Topaz of the ancients.

† Ann. de
Chim.
xxviii. 200.

81
G. XVIII.
MSI.

The name *chrysolite* was applied, without discrimination, to a great variety of stones, till Werner defined it accurately, and confined it to that stone which the French chemists distinguish by the appellation of *peridot*. This stone is the *topaz* of the ancients; their chrysolite is now called *topaz**.

* Plinii, lib.

Chrysolite is found sometimes in unequal fragments, 37. c. 8. and sometimes crystallized †. The primitive form of its crystals is a right angled parallelepiped †, whose length, breadth, and thickness, are as 5, $\sqrt{8}$, $\sqrt{5}$ §.

The texture of the chrysolite is foliated. Its fracture conchoidal. Its internal lustre from 2 to 4. Its transparency from 4 to 2. Causes double refraction. Hardness 281.

† Haüy,
Jour. de
Min. N^o
xxviii.

The carbonat of lime was only mechanically interposed between the fibres of the stone. See Pallas, Neu. Nord. Beitr. 6 Band, p. 146.

(E) Hence the name *kiff-kil*, or rather *keff-kelli*, "clay froth," or "light clay."

(F) Kirw. I. 151.—Pott, Mem. Berlin, 1747, p. 57.—Wiegleb, Jour. de Phys. XXIX. 60.—Lavoisier, Mem. Par. 1778, 433.

(G) Kirw. I. 262.—Cartheuser, Min. 94.—Dolomieu, Jour. de Min. N^o xxix. 365.—La Metherie, Nouv. Jour. de Phys. I. 397.

Earths and Hardness 9 to 10. Brittle. Sp. gr. from 3.265 to 3.45. Colour green. It is infusible at 150°, but loses its transparency, and becomes blackish grey*. With borax it melts without effervescence into a transparent glass of a light green colour. Infusible with microcosmic

† Vauquelin, falt † and fixed alkali †.

Ann. de Chim. xxi.

Variety 1. Common chrysolite.

97. Found in Ceylon, and South America, and in Bohemia, amidst sand and gravel §. Lustre 3 to 4. Transparency 4 to 3. Colour yellowish green, sometimes verging to olive green, sometimes to pale yellow.

* Kirwan's Min. i.

Variety 2. Olive chrysolite—Olivine*.

263—Le Lievre, Jour. de Phys. xxx. 397. Found commonly among traps and basalts; sometimes in small grains, sometimes in pretty large pieces; but it has not been observed in crystals. Lustre 2 to 3. Transparency 3 to 2. Colour olive green.

The first variety, according to the analysis of Klaproth, is composed of 41.5 magnesia,

38.5 silica,

19.0 oxide of iron.

† Klaproth's Beiträge, i. 103.

According to that of Vauquelin, it is composed of

51.5 magnesia,

38.0 silica,

9.5 oxide of iron.

† Ann. de Chim. ibid.

99.0 †

The second variety, according to the analysis of Klaproth, is composed of 37.58 magnesia,

50.00 silica,

11.75 oxide of iron,

.21 lime.

99.54 §

§ Beiträge, i. 112.

SPECIES 2. Jade (H).

Jade. This stone was formerly called *lapis nephriticus*, and was much celebrated for its medical virtues. It is found in Egypt, China, America, and in the Siberian and Hungarian mountains. It is sometimes adhering to rocks, and sometimes in detached round pieces.

Its surface is smooth. Its fracture splintery. External lustre 0, or scarce 1; internal waxy, 1. Transparency from 2 to 1. Hardness 10. Not brittle. Sp. gr. from 2.95 to 2.9829; or, according to Saussure, to 3.389. Feels greasy. Looks as if it had imbibed oil. Colour dark leek green, or verging towards blue; in some prominences inclining to greenish or bluish white. When heated it becomes more transparent and brittle, but is infusible *per se*. According to Hoepfner, it is composed of

47 silica,

38 carbonat of magnesia,

9 iron,

4 alumina,

2 carbonat of lime.

100

This is the stone in which the inhabitants of New Zealand make into hatchets and other cutting instruments.

(H) Kirw. I. 171.—Bartolin, De Lapide Nephritico.—Lehman, Nov. Comm. Petropol. X. 381.—Hoepfner, Hist. Nat. de la Suisse, I. 251.

(1) Kirw. I. 159.—Bergman, IV. 160.—Plot, Phil. Transf. XV. 1051.—Nebel, Jour. de Phys. II. 62.—Ibid. III. 367.

SUPPL. VOL. II. Part I.

GENUS XIX. SML.

SPECIES 1. Asbestus (1).

This mineral was well known to the ancients. They even made a kind of cloth from one of the varieties, which was famous among them for its incombustibility. It is found abundantly in most mountainous countries, and no where more abundantly than in Scotland.

It is commonly amorphous. Its texture is fibrous. Its fragments often long splintery. Lustre from 0 to 2; sometimes 3, and then it is metallic. Transparency from 0 to 2. Hardness from 3 to 7. Sp. gr. from 2.7 to 0.6806. Absorbs water. Colour usually white or green. Fusible *per se* by the blow-pipe.

Variety 1. Common asbestus.

Lustre 2 to 1. Transparency 1. Hardness 6 to 7. Sp. gr. 2.577 to 2.7. Feels somewhat greasy. Colour leek green; sometimes olive or mountain green; sometimes greenish or yellowish grey. Streak grey. Powder grey.

Variety 2. Flexible asbestus.

Amiantus.

Composed of a bundle of threads slightly cohering. Fibres flexible. Lustre 1 to 2, sometimes 3. Transparency 1 to 2, sometimes 0. Hardness 3 to 4. Sp. gr. before it absorbs water, from 0.9088 to 2.3134; after absorbing water, from 1.5662 to 2.3803*. Feels greasy. Colour greyish or greenish white; sometimes yellowish or silvery white, olive or mountain green, pale flesh red, and mountain yellow.

Variety 3. Elastic asbestus.

Mountain cork.

This variety has a strong resemblance to common cork. Its fibres are interwoven. Lustre commonly 0. Opaque. Hardness 4. Sp. gr. before absorbing water, from 0.6806 to 0.9933; after absorbing water, from 1.2492 to 1.3492. Feels meagre. Yields to the fingers like cork, and is somewhat elastic. Colour white; sometimes with a shade of red or yellow; sometimes yellow or brown.

A specimen of the first variety from Dalecarlia, analysed by Bergman, contained

63.9 silica,

16.0 carbonat of lime,

12.8 carbonat of magnesia,

6.0 oxide of iron,

1.1 alumina.

99.8 *

A specimen of the second variety yielded to the same chemist

64.0 silica,

17.2 carbonat of magnesia,

13.9 carbonat of lime,

2.7 alumina,

2.2 oxide of iron.

100.0 †

A specimen of the third variety contained, according to the same analysis,

56.2 silica,

26.1 carbonat of magnesia,

12.7 carbonat of lime,

3.0 iron,

2.0 alumina.

100.0 §

Twelve §

170.

Earths and Stones. Twelve different specimens of asbestos, analysed by Bergman, yielded the same ingredients, differing a little in their proportions *.

* *Opusc. iv.*
175.
86
Asbestinite.

SPECIES 2. Asbestinite (κ).

This stone is amorphous. Texture foliated or broad striated. Lustre silky, 3. Transparency 1 to 2. Hardness 5 to 6. Sp. gr. from 2.806 to 2.880. Colour white with shades of red, yellow, green or blue. At 150° Wedgewood it melts into a green glass.

87
G. XX. I.
SILM.
Pyroxen.

GENUS XX. I. SILM.

SPECIES 1. Pyroxen.

This stone is found abundantly in lava and other volcanic productions (L). It is always crystallized. The primitive form of its crystals is an oblique angled prism, whose bases are rhombs with angles of 92° 18', and 37° 42' †. It generally crystallizes in eight-sided prisms, terminated by dihedral summits ‡. Its texture is foliated. Hardness 9. Colour black; sometimes green. Powder greenish grey §. Commonly attracted by the magnet *. Scarcely fusible by the blow pipe †. With borax it melts into a yellowish glass, which appears red while it is hot ‡.

† Haüy,
Tour. de
Min. N°
xxviii. 269.
‡ De Lisle,
ii. 398.
§ Vauquelin
* Ferber.
† Le Lievre.
‡ Vauquelin.

According to the analysis of Vauquelin, it is composed of

52.00 silica,
14.66 oxide of iron,
13.20 lime,
10.00 magnesia,
3.33 alumina,
2.00 oxide of manganese.

§ *Tour de*
Min. N°
xxxix. 172.
88
Asbestoid.
* Kirwan,
i. 166.

95.19 §

SPECIES 2. Asbestoid *.

This stone has obtained its name from its similarity to common asbestos. It is amorphous. Its texture is foliated or striated. Its lustre common or glassy, from 2 to 3. Transparency from 0 to 1. Hardness 6 to 7. Sp. gr. from 3 to 3.31. Colour olive or leek green; when decomposing, brown. Before the blow-pipe it melts *per se* into a brown globule. With borax it forms a violet-coloured globule verging towards hyacinth *. According to the analysis of Mr Macquart, it is composed of

* Macquart,
Ann. de
Chim. xxii.
83.

46 silica,
20 oxide of iron,
11 lime,
10 oxide of manganese,
8 magnesia.

† *Ibid.*

95 †

There is a variety of this species which Kirwan calls metalliform asbestoid. Its lustre is femimetallic, 3. Opaque. Hardness 8 to 9. Sp. gr. 3.356. Colour grey, sometimes inclining to red ‡.

‡ Kirwan's
Min. i. 167.

GENUS XX. 2. SMIL.

SPECIES 3. Shorlaceous actinolite (M).

This stone crystallizes in four or six sided prisms, thicker at one end than the other; hence it has been called by the Germans *strahlstein*, "arrow-stone." The crystals sometimes adhere longitudinally. Fracture hackly. External lustre glassy, 3 to 4; internal, 1 to 2. Transparency from 2 to 3; sometimes 1. Hardness from 7 to 10. Sp. gr. 3.023 to 3.45. Colour leek or dark green.

This stone is often the matrix of iron, copper, and tin ores.

SPECIES 5. Lamellar actinolite.

This stone resembles hornblende. It is amorphous. Texture foliated. Lustre various in different places. Transparency 0, or scarce 1. Sp. gr. 2.916. Colour dark yellowish or greenish grey.

SPECIES 6. Glassy actinolite.

This stone is found amorphous, composed of fibres adhering longitudinally, or in slender four or six sided prisms. Texture fibrous. Fragments long splintery, so sharp that they can scarcely be handled without injury. External lustre glassy or silky, 3 to 4; internal 0. Transparency 2. Exceedingly brittle. Sp. gr. 2.95 to 2.493. Colour leek green; sometimes verging towards greenish or silver white; sometimes stained with yellowish or brownish red. According to Bergman it is composed of

72.0 silica,
12.7 carbonat of magnesia,
6.0 carbonat of lime,
7.0 oxide of iron,
2.0 alumina.

99.7 §

GENUS XXI. SL.

SPECIES 1. Shistose hornstone *.

The structure of this stone is slaty. Lustre from 0 to 1. Commonly opaque. Hardness 9 to 10. Sp. gr. from 2.596 to 2.641. Colour dark bluish or blackish grey. Infusible *per se*.

Variety 1. Siliceous shistose.

Commonly intersected by reddish veins of iron stone. Fracture splintery. Lustre 0. Transparency from 0 to 1.

Variety 2. Bafanite or Lydian stone.

Commonly intersected by veins of quartz. Fracture even; sometimes inclining to conchoidal. Lustre scarce 1. Hardness 10. Sp. gr. 2.596. Powder black. Colour greyish black.

This, or a stone similar to it, was used by the ancients as a touchstone. They drew the metal to be examined along the stone, and judged of its purity by the

Simple
Stones.

89
G. XX. 2.
SMIL.
Shorlaceous
actinolite.

90
Lamellar
actinolite.91
Glassy acti-
nolite.§ *Opusc. iv.*
171.

92
G. XXI. SL.
Shistose
hornstone.
* Kirwan,
i. 305.

(κ) Kirw. Min. I. 165. Is this the tremolite of Werner? It certainly is not the tremolite of the French mineralogists.

(L) Hence the name pyroxen given it by Haüy; from *πυρ* fire, and *ξωος*, a stranger. It means, as he himself explains it, a stranger in the regions of fire. By this he means to indicate, that pyroxen, though present in lava, is not a volcanic production.

(M) In this and the following species we have followed Mr. Kirwan's new arrangement exactly, without even venturing to give the synonyms of other authors. The descriptions which have been given are so many and incomplete, and the minerals themselves are still so imperfectly known, and have got so many names, that no part of mineralogy is in a state of greater confusion.

Earth and the colour of the metallic streak. On this account they called it *βαλανς*, the *trier*. They called it also *Ly-dian stone*, because, as Theophrastus informs us, it was found most abundantly in the river Tmolus in Lydia *.
* *Hill*, *Theophrastus*, A specimen of the first variety, analysed by Wieg-leb, contained
75.0 silica,
10.0 lime,
4.6 magnesia,
3.5 iron,
5.2 carbon.
98.3
This species is rather a mechanical mixture than a chemical combination.

93
G. XXII.
Zs.
Zircon.
† *Kirwan*, i. 257. and 333.
‡ Fig. 25.
§ *Haüy*, *Four. de Min.* N^o xxvi. 91.
|| Fig. 26.
¶ *Ibid.*
* *Ibid.*
GENUS XXII. ZS.
SPECIES I. Zircon †.
Jargon—Hyacinth.
This stone is brought from Ceylon, and found also in France, Spain, and other parts of Europe. It is commonly crystallized. The primitive form of its crystals is an octahedron ‡, composed of two four-sided pyramids applied base to base, whose sides are isosceles triangles (N). The inclination of the sides of the same pyramid to each other is 124° 12'; the inclination of the sides of one pyramid to those of another 82° 50'. The solid angle at the apex is 73° 44' §. The varieties of the crystalline forms of zircon amount to seven. In some cases there is a four-sided prism interposed between the pyramids of the primitive form; sometimes all the angles of this prism are wanting, and two small triangular faces in place of each; sometimes the crystals are dodecahedrons, composed of a flat four-sided prism with hexagonal faces, terminated by four-sided summits with rhomboidal faces ||; sometimes the edges of this prism, sometimes the edges where the prism and summit join, and sometimes both together, are wanting, and we find small faces in their place. For an accurate description and figure of these varieties, we refer to *Mr Haüy* ¶.

The texture of the zircon is foliated. Internal lustre 3. Transparency from 4 to 2. Causes a very great double refraction. Hardness from 10 to 16. Sp. gr. from 4.2 to 4.165 *. Colour commonly reddish or yellowish; sometimes it is limpid.
Before the blow-pipe it loses its colour, but not its transparency. With borax it melts into a transparent glass. Infusible with fixed alkali and microcosmic salt.
1. The variety formerly called *hyacinth* is of a yellowish red colour, mixed with brown. Its surface is smooth. Its lustre 3. Its transparency 3 to 4.
2. The variety formerly called *jargon of Ceylon*, is either grey, greenish, yellowish brown, reddish brown, or violet. It has little external lustre. Is sometimes nearly opaque.
The first variety, according to the analysis of Vauquelin, is composed of
64.5 zirconia,
32.0 silica,
2.0 oxide of iron.
98.5 †
† *Ibid.* p. 106.

A specimen analysed by Klaproth contained
70.0 zirconia,
25.0 silica,
0.5 oxide of iron.
95.5 *
The second variety, according to Klaproth, who dis- i. 231.
covered the component parts of both these stones, con-
tains
60.0 zirconia,
31.5 silica,
0.5 nickel and iron.
100.0 ‡
‡ *Ibid.* i. 219.

ORDER II. SALINE STONES. 94
Genera.
UNDER this order we comprehend all the minerals which consist of an earthy basis combined with an acid. They naturally divide themselves into five genera. We shall describe them in the following order.

- I. CALCAREOUS SALTS.
Carbonat of lime,
Sulphat of lime,
Phosphat of lime,
Fluat of lime,
Borat of lime.
- II. BARYTIC SALTS.
Carbonat of barytes,
Sulphat of barytes.
- III. STRONTITIC SALTS.
Carbonat of strontites,
Sulphat of strontites.
- IV. MAGNESIAN SALTS.
Sulphat of magnesia.
- V. ALUMINOUS SALTS.
Alum.

GENUS I. CALCAREOUS SALTS. 95
G. I. Cal-
This genus comprehends all the combinations of lime careous
and acids which form a part of the mineral kingdom. salts.
SPECIES I. Carbonat of lime. 96
Carbonat
of lime.
No other mineral can be compared with carbonat of lime in the abundance with which it is scattered over the earth. Many mountains consist of it entirely, and hardly a country is to be found on the face of the globe where, under the names of limestone, chalk, marble, spar, it does not constitute a greater or smaller part of the mineral riches.
It is often amorphous, often stalactitical, and often crystallized. The primitive form of its crystals is a parallelopiped, whose sides are rhombs, with angles of 77° 30' and 102° 30' †. Its integrant molecules have the same form. The varieties of its crystals amount to more than 40; for a description and figure of which we refer to *Romé de Lisle* * and *Haüy* (o).
When crystallized, its texture is foliated; when amor- 497.
phous, its structure is sometimes foliated, sometimes striated, sometimes granular, and sometimes earthy. Its
E e 2 lustre

(N) Let ABC (fig. 27.) be one of the sides. Draw the perpendicular BD; then AB = 5, BD = 4, AD = 3.
(o) *Essai d'une Theorie*, &c. p. 75.—*Four. de Phys.* 1793, August, p. 114.—*Four. d'Hist. Nat.* 1792, Febru-
ary, p. 148.—*Ann. de Chim.* XVII. 249. &c.—*Four. de Min.* N^o XXVIII. 304.

Earths and
Stones.

lustre varies from 0 to 3. Transparency from 0 to 4. It causes double refraction; and it is the only mineral which causes double refraction through two parallel faces of the crystal. Hardness from 3 to 9. Sp. gr. from 2.315 to 2.78. Colour, when pure, white. Effervesces violently with muriatic acid, and dissolves completely, or leaves but a small residuum. The solution is colourless.

This species occurs in a great variety of forms; and therefore has been subdivided into numerous varieties. All these may be conveniently arranged under two general divisions.

1. Soft carbonat of lime.

Variety 1. Agaric mineral.

Mountain milk, or *mountain meal* of the Germans.

This variety is found in the clefts of rocks, or the bottom of lakes. It is nearly in the state of powder; of a white colour, sometimes with a shade of yellow; and so light that it almost floats on water.

Variety 2. Chalk.

The colour of chalk is white, sometimes with a shade of yellow. Lustre 0. Opaque. Hardness 3 to 4. Sp. gr. from 2.315 to 2.657. Texture earthy. Adheres slightly to the tongue. Feels dry. Stains the fingers, and marks. Falls to powder in water. It generally contains about $\frac{1}{100}$ of alumina, and $\frac{1}{100}$ of water; the rest is carbonat of lime.

Variety 3. Arenaceous limestone.

Colour yellowish white. Lustre 1. Transparency 1. So brittle that small pieces crumble to powder between the fingers. Sp. gr. 2.742. Phosphoresces in the dark when scraped with a knife, but not when heated. It consists almost entirely of pure carbonat of lime.

Variety 4. Testaceous tufa.

The colour of this variety is yellowish or greyish white. It is exceedingly porous and brittle; and is either composed of broken shells, or resembles mortar containing shells; or it consists of fistulous concretions variously ramified, and resembling moss.

II. Indurated carbonat of lime.

Variety 1. Compact limestone.

The texture of this variety is compact. It has little lustre; and is most commonly opaque. Hardness 5 to 8. Sp. gr. 1.3864 to 2.72. Colour grey, with various shades of other colours. It most commonly contains about $\frac{1}{100}$ th of alumina, oxide of iron, &c.; the rest is carbonat of lime. This variety is usually burnt as lime.

Variety 2. Granularly foliated limestone.

Structure sometimes flaty. Texture foliated and granular. Lustre 2 to 1. Transparency 2 to 1. Hardness 7 to 8. Sp. gr. 2.71 to 2.8376. Colour white, of various shades from other colours.

Variety 3. Sparry limestone.

Structure sparry. Texture foliated. Fragments rhomboidal. Lustre 2 to 3. Transparency from 2 to 4; sometimes 1. Hardness 5 to 6. Sp. gr. from 2.693 to 2.718. Colour white; often with various shades of other colours. To this variety belong all the crystals of carbonat of lime.

Variety 4. Striated limestone.

Texture striated or fibrous. Lustre 1 to 0. Transparency 2 to 1. Hardness 5 to 7. Sp. gr. commonly from 2.6 to 2.77. Colours various.

Variety 5. Swine stone.

Texture often earthy. Fracture often splintery. Lustre 1 to 0. Transparency 0 to 1. Hardness 6 to 7. Sp. gr. 2.701 to 2.7121. Colour dark grey, of various shades. When scraped or pounded it emits an urinous or garlic smell.

Variety 6. Oviform.

This variety consists of a number of small round bodies, closely compacted together. Lustre 0. Transparency 0 or 1. Hardness 6 to 7.

SPECIES 2. Sulphat of lime.

Gypsum—*Selenite*.

This mineral is found abundantly in Germany, France, England, Italy, &c.

It is found sometimes in amorphous masses, sometimes in powder, and sometimes crystallized. The primitive form of its crystals, according to Romé de Lisle, is a decahedron*, which may be conceived as two four-sided pyramids applied base to base, and which, instead of terminating in pointed summits, are truncated near their bases; so that the sides of the pyramids are trapeziums, and they terminate each in a rhomb. These rhombs are the largest faces of the crystal. The angles of the rhombs are 52° and 158° . The inclination of two opposite faces of one pyramid to the two similar faces of the other pyramid is 145° , that of the other faces 110° .† Sometimes some of the faces are elongated; sometimes it crystallizes in six-sided prisms, terminated by three or four-sided summits, or by an indeterminate number of curvilinear faces. For a description and figure of these varieties, we refer to *Romé de Lisle* †.

The texture of sulphat of lime is most commonly foliated. Lustre from 0 to 4. Transparency from 0 to 4. It causes double refraction. Its hardness does not exceed 4. Its sp. gr. from 1.872 to 2.311. Colour commonly white or grey.

Before the blow-pipe, it melts into a white enamel, provided the blue flame be made to play upon the edges of its laminæ. When the flame is directed against its faces, the mineral falls into powder ‡.

It does not effervesce with muriatic acid, except it be impure; and it does not dissolve in it.

The following varieties of this mineral are deserving of attention.

Variety 1. Broad foliated sulphat.

Texture broad foliated. Lustre glassy, from 4 to 2. Transparency from 4 to 3. Hardness 4. Sp. gr. 2.311. Colour grey, often with a shade of yellow.

Variety 2. Grano-foliated sulphat.

Texture foliated, and at the same time granular; so that it easily crumbles into powder. Lustre 2 to 3. Transparency 2 to 3. Hardness 4 to 3. Sp. gr. from 2.274 to 2.310. Feels soft. Colour white or grey, often with a tinge of yellow, blue, or green; sometimes flesh red, brown, or olive green.

Variety 3. Fibrous sulphat.

Texture fibrous. Fragments long splintery. Lustre 2 to 3. Transparency 2 to 1; sometimes 3. Hardness 4. Brittle. Sp. gr. 2.300. Colour white, often with a shade of grey, yellow, or red; sometimes flesh red, and sometimes honey yellow; sometimes several of these colours meet in stripes.

Variety 4. Compact sulphur.

Texture compact. Lustre 1 or 0. Transparency 2 to

Saline
Stones.97
Sulphat of
lime.

* Fig. 29.

† *Crystal*.
144.‡ *Ibid*.§ *Le Lievre*,
Jour. de
Min. N^o
xxviii. 315.

Order II.

MINERALOGY.

221

Earths and 1, sometimes o. Hardness 4. Sp. gr. from 1.872 to 2.288. Feels dry, but not harsh. Colour white, with a shade of grey, yellow, blue, or green; sometimes yellow; sometimes red; sometimes spotted, striped, or veined.

Variety 5. Farinaceous sulphat.

Of the consistence of meal. Lustre o. Opaque. Scarcely sinks in water. Is not gritty between the teeth. Feels dry and meagre. Colour white. When heated below redness, it becomes of a dazzling white.

SPECIES 3. Phosphat of lime.

Phosphat of lime. *Apatite—Phosphorite—Chrysolite*—of the French.

This substance is found in Spain, where it forms whole mountains, and in different parts of Germany. It is sometimes amorphous, and sometimes crystallized. The primitive form of its crystals is a regular six-sided prism*. Its integrant molecule is a regular triangular prism, whose height is to a side of its base as 1 to $\sqrt{2}$ †. Sometimes the edges of the primitive hexagonal prism are wanting, and small faces in their place; sometimes there are small faces instead of the edges which terminate the prism; sometimes these two varieties are united; sometimes the terminating edges and the angles of the prism are replaced by small faces‡; and sometimes the prism is terminated by four sided pyramids§.

Its texture is foliated. Its fracture uneven, tending to conchoidal. External lustre from 2 to 3, internal 3 to 2. Transparency from 4 to 2. Causes single refraction. Hardness 6 to 7. Brittle. Sp. gr. from 2.8249 to 3.218. Colour commonly green or grey; sometimes brown, red, blue, and even purple.

It is infusible by the blow-pipe. When its powder is thrown upon burning coals, it emits a yellowish green phosphorescent light. It is soluble in muriatic acid without effervescence or decomposition, and the solution often becomes gelatinous.

SPECIES 4. Fluat of lime.

Fluor.

This mineral is found abundantly in different countries, particularly in Derbyshire. It is both amorphous and crystallized.

The primitive form of its crystals is the regular octohedron; that of its integrant molecules the regular tetrahedron||. The varieties of its crystals hitherto observed amount to 7. These are the primitive octohedron; the cube; the rhomboidal dodecahedron; the cubo octohedron¶, which has both the faces of the cube and of the octohedron; the octohedron wanting the edges; the cube wanting the edges, and either one face*, or two faces in place of each. For a description and figure of these we refer to Mr Haüy†.

The texture of fluat of lime is foliated. Lustre from 2 to 3, sometimes o. Transparency from 2 to 4, sometimes 1. Causes single refraction. Hardness 8. Very brittle. Sp. gr. from 3.0943 to 3.1911. Colours numerous, red, violet, green, red, yellow, blackish purple. Its powder thrown upon hot coals emits a bluish or greenish light. Two pieces of it rubbed in the dark phosphoresce. It decrepitates when heated. Before the blow-pipe it melts into a transparent glass.‡

It admits of a polish, and is often formed into vases and other ornaments.

SPECIES 5. Borat of lime.

Boracite.

This mineral has been found at Ka lkberg near Lu-

neburg, seated in a bed of sulphat of lime. It is crystallized. The primitive form of its crystals is the cube*. In general, all the edges and angles of the cube are truncated; sometimes, however, only the alternate angles are truncated†. The size of the crystals does not exceed half an inch.

The texture of this mineral is compact. Its fracture is flat conchoidal. External lustre 3; internal, greasy. Transparency from 2 to 3. Hardness 9 to 10. Sp. gr. 2.566. Colour greyish white, sometimes passing into greenish white or purplish.

When heated it becomes electric; and the angles of the cube are alternately positive and negative‡.

Before the blow-pipe it froths, emits a greenish light, and is converted into a yellowish enamel, garnished with small points, which, if the heat be continued, dart out in sparks§.

According to Westrum, who discovered its component parts, it contains

68 boracic acid,
13.5 magnesia,
11 lime,
1 alumina,
2 silica,
1 iron.

96 ¶

SPECIES 6. Nitrat of lime.

Found abundantly mixed with native nitre. For a description see the article CHEMISTRY in this Supplement, n° 672.

GENUS II. BARYTIC SALTS.

This genus comprehends the combinations of barytes with acids.

SPECIES 1. Carbonat of barytes.

Witherite.

This mineral was discovered by Dr Withering; hence Weyner has given it the name of *witherite*. It is found both amorphous and crystallized. The crystals are octohedrons or dodecahedrons, consisting of four or six sided pyramids applied base to base; sometimes the fixed pyramids are separated by a prism; sometimes several of these prisms are joined together in the form of a star.

Its texture is fibrous. Its fracture conchoidal. Its fragments long splintery. Lustre 2. Transparency 2 to 3. Hardness 5 to 6. Brittle. Sp. gr. 4.3 to 4.338. Colour greenish white. When heated it becomes opaque. Its powder phosphoresces when thrown on burning coals*.

It is soluble with effervescence in muriatic acid. The solution is colourless.

According to Pelletier it contains

62 barytes,
22 carbonic acid,
16 water.

100 †

SPECIES 2. Sulphat of barytes.

Borofelenite.

This mineral is found abundantly in many countries, particularly in Britain. It is sometimes in powder, often in amorphous masses, and often crystallized. The primitive form of its crystals is a rectangular prism, whose

Saline Stones.

Haüy, Jour. de Min. N° xxvii. p. 325.

Haüy, and Westrum.

Haüy, ibid. and Ann. de Chim. ix. 59.

Le Lievre, Jour. de Min. ibid.

Ann. de Chim. ii. 101.

Nitrat of lime. 102

G. H. Barytic salts.

103 Carbonat of barytes.

Haüy.

Four. de Min. N° xxi. p. 46.

104 Sulphat of barytes.

100 Borat of lime.

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

Earth and whose bases are rhombs, with angles of $101^{\circ} 30'$ and $78^{\circ} 30'$. The varieties of its crystals are very numerous. For a description and figure of them we refer

* Haüy, *Essai d'une Théorie, &c.* p. 119. † *Crystall.* i. 588. ‡ *Ibid.* and *Ann. de Chim.* xii. 3. to *Romé de Lisle* † and *Haüy* ‡. The most common varieties are the octohedron with cuneiform summits, the six or four sided prism, the hexangular table with bevelled edges. Sometimes these crystals are needle form.

Its texture is commonly foliated. Lustre from 0 to 2. Transparency from 2 to 0; in some cases 3 or 4. Hardness from 5 to 6. Sp. gr. from 4.4 to 4.44. Colour commonly white, with a shade of yellow, red, blue, or brown.

When heated it decrepitates. It is fusible *per se* by the blue flame of the blow-pipe, and is converted into sulphur of barytes. Soluble in no acid except the sulphuric; and precipitated from it by water.

Variety 1. Foliated sulphat.

Lustre 3 to 3. Transparency from 4 to 2, sometimes 1. Colours white, reddish, bluish, yellowish, blackish, greenish. Mr Werner subdivides this variety into three, according to the nature of the texture. These three subdivisions are *granularly foliated*, *straight foliated*, *curved foliated*.

Variety 2. Fibrous sulphat.

Texture fibrous; fibres converging to a common centre. Lustre silky or waxy. 2. Transparency 2 to 1. Hardness 5. Colours yellowish, bluish, reddish.

Variety 3. Compact sulphat.

Texture compact. Lustre 0 to 1. Transparency 1 to 0. Feels meagre. Almost constantly impure. Colours light yellow, red, or blue.

Variety 4. Earthy sulphat.

In the form of coarse dusty particles, slightly cohering. Colour reddish or yellowish white.

GENUS III. STRONTITIC SALTS.

105
G. III.
Strontitic
salts.

This genus comprehends all the combinations of strontites and acids which form a part of the mineral kingdom.

SPECIES 1. Carbonat of strontites

106
Carbonat of
strontites.

This mineral was first discovered in the lead mine of Strontion in Argyleshire; and since that time it is said to have been discovered, though not in great abundance, in other countries. It is found amorphous, and also crystallized in needles, which, according to Haüy, are regular six-sided prisms.

Its texture is fibrous; the fibres converge. Fracture uneven. Lustre 2. Transparency 2. Hardness 5. Sp. gr. from 3.4 to 3.66. Colour light green. Does not decrepitate when heated. Before the blow-pipe becomes opaque and white, but does not melt. With borax it effervesces, and melts into a transparent colourless glass. Effervesces with muriatic acid, and is totally dissolved. The solution tinges flame purple.

SPECIES 2. Sulphat of strontites.

Celestine.

107
Sulphat of
strontites.

This mineral has been found in Pennsylvania, in Germany, in France, in Sicily, and Britain. It was first discovered near Bristol by Mr Clayfield. There it is found in such abundance, that it has been employed in mending the roads.

It occurs both amorphous and crystallized. The crystals are most commonly bevelled tables, sometimes rhomboidal cubes. Its texture is foliated. More or

less transparent. Hardness 5. Sp. gr. from 3.51 to 3.96. Colour most commonly a fine sky blue; sometimes reddish; sometimes white, or nearly colourless.

Klaproth found a specimen of this mineral from Pennsylvania composed of 58 strontites, 42 sulphuric acid.

100 ||.

According to the analysis of Mr Clayfield, the sulphat strontites found near Bristol is composed of

58.25 strontites, 41.75 sulphuric acid of 2.24, and a little iron.

100.00

According to the analysis of Vauquelin, the sulphat of strontites found at Bouvron in France, which was contaminated with .1 of carbonat of lime, is composed of

54 strontites, 45 sulphuric acid.

99 *

GENUS IV. MAGNESIAN SALTS.

This genus comprehends the combinations of magnesia and acids which occur in the mineral kingdom. Only two species have hitherto been found; namely,

SPECIES 1. Sulphat of magnesia.

It is found in Spain, Bohemia, Britain, &c.; and enters into the composition of many mineral waters.

For a description of it, we refer to CHEMISTRY, n° 633. in this *Suppl.*

SPECIES 2. Nitrat of magnesia.

Found sometimes associated with nitre. For a description see CHEMISTRY, n° 674.

GENUS V. ALUMINOUS SALTS.

This genus comprehends those combinations of alumina and acids which occur in the mineral kingdom.

SPECIES 1. Alum.

This salt is found in crystals, in soft masses, in flakes, and invisibly mixed with the soil. For a description, we refer to CHEMISTRY, n° 636.

ORDER III. AGGREGATES.

THIS order comprehends all mechanical mixtures of earths and stones found in the mineral kingdom. These are exceedingly numerous: the mountains and hills, the mould on which vegetables grow, and indeed the greater part of the globe, may be considered as composed of them. A complete description of aggregates belongs rather to geology than mineralogy. It would be improper, therefore, to treat of them fully here. But they cannot be altogether omitted; because aggregates are the first substances which present themselves to the view of the practical mineralogist, and because, without being acquainted with the names and component parts of many of them, the most valuable mineralogical works could not be understood.

Aggregates may be comprehended under four divisions: 1. Mixtures of earths; 2. Amorphous fragments of stones agglutinated together; 3. Crystallized stones, either agglutinated together or with amorphous stones; 4. Aggregates formed by fire. It will be exceedingly convenient

Earths and
Stones.

convenient to treat each of these separately. We shall therefore divide this order into four sections.

SECT. I. *Aggregates of Earths.*

The most common earthy aggregates may be comprehended under the following genera:

1. Clay,
2. Colorific earths,
3. Marl,
4. Mould.

GENUS I. CLAY.

Clay is a mixture of alumina and silica in various proportions. The alumina is in a state of an impalpable powder; but the silica is almost always in small stones, large enough to be distinguished by the eye. Clay, therefore, exhibits the character of alumina, and not of silica, even when this last ingredient predominates. The particles of silica are already combined with each other; and they have so strong an affinity for each other that few bodies can separate them; whereas the alumina, not being combined, readily displays the characters which distinguish it from other bodies. Besides alumina and silica, clay often contains carbonate of lime, of magnesia, barytes, oxide of iron, &c. And as clay is merely a mechanical mixture, the proportion of its ingredients is exceedingly various.

Clay has been divided into the following species:

SPECIES I. Porcelain clay.

Its texture is earthy. Its lustre o. Opaque. Hardness 4. Sp. gr. from 2.23 to 2.4. Colour white, sometimes with a shade of yellow or red. Adheres slightly to the tongue. Feels soft. Falls to powder in water.

A specimen, analysed by Hassenfratz, contained

62 silica,
19 alumina,
12 magnesia,
7 sulphat of barytes.

100*

A specimen, analysed by Mr Wedgewood, contained

60 alumina,
20 silica,
12 air of water.

—

92

SPECIES 2. Common clay.

Its texture is earthy. Lustre o. Opaque. Hardness 3 to 6. Sp. gr. 1.8 to 2.68. Adheres slightly to the tongue. Often feels greasy. Falls to powder in water. Colour, when pure, white; often tinged blue or yellow.

Variety 1. Potter's clay.

Hardness 3 to 4. Sp. gr. 1.8 to 2. Stains the fingers slightly. Acquires some polish by friction. Colour white; often with a tinge of yellow or blue; sometimes brownish, greenish, reddish. Totally diffusible in water; and, when duly moistened, very ductile.

Variety 2. Indurated clay.

Hardness 5 to 6. Does not diffuse itself in water, but falls to powder. Discovers but little ductility. Colours grey, yellowish, bluish, greenish, reddish, brownish.

Variety 3. Shistose clay.

Structure slaty. Sp. gr. from 2.6 to 2.68. Feels smooth. Streak white or grey. Colour commonly bluish, or yellowish grey; sometimes blackish, reddish, greenish. Found in strata, usually in coal mines.

This variety is sometimes impregnated with bitumen. It is then called bituminous shale.

SPECIES 3. Lithomarga.

Texture earthy. Fracture conchoidal. Lustre from o to 2. Opaque. Hardness 3 to 7. Sp. gr. when pretty hard, 2.815. Surface smooth, and feels soapy. Adheres strongly to the tongue. Falls to pieces, and then to powder, in water; but does not diffuse itself through that liquid. Fusible *per se* into a frothy mass.

Variety 1. Friable lithomarga.

Formed of scaly particles slightly cohering. Lustre 1 to o. Hardness 3 to 4. Exceedingly light. Feels very smooth, and assumes a polish from the nail. Colour white; sometimes tinged yellow or red.

Variety 2. Indurated lithomarga.

Hardness 4 to 7. The softer sorts adhere very strongly to the tongue when newly broken; the harder very moderately. Colours grey, yellow, red, brown, blue.

A specimen of lithomarga from Osmund, analysed by Bergman, contained

60.0 silica,
11.0 alumina,
5.7 carbonate of lime,
4.7 oxide of iron,
0.5 carbonate of magnesia,
18.0 water and air.

99.9*

SPECIES 4. Bole.

Texture earthy. Fracture conchoidal. Lustre o. Transparency scarce 1. Hardness 4. Sp. gr. from 1.4 to 2. Acquires a polish by friction. Scarcely adheres to the tongue. Feels greasy. Colour yellow or brown; sometimes red; sometimes spotted.

The lemnian earth which belongs to this species, according to the analysis of Bergman, contains

47.0 silica,
19.0 alumina,
6.0 carbonate of magnesia,
5.4 carbonate of lime,
5.4 oxide of iron,
17.0 water and air.

99.8†

SPECIES 5. Fullers earth.

Texture earthy. Structure sometimes slaty. Fracture imperfectly conchoidal. Lustre o. Opaque. Hardness 4. Receives a polish from friction. Does not adhere to the tongue. Feels greasy. Colour usually light green.

A specimen from Hampshire, analysed by Bergman, contained

51.8 silica,
25.0 alumina,
3.3 carbonate of lime,
3.7 oxide of iron,
0.7 carbonate of magnesia,
15.5 moisture.

100.0‡

Aggregates

117
Lithomarga.* *Opusc. iv.*
118
Bole.† *Ibid. p.*
157.
119
Fullers
earth.‡ *Ibid. 159.*
This114
Clay.115
Porcelain
clay.* *Ann. de
Chim. xiv.*
144.116
Common
clay.

Earths and
Stones.

This earth is used by fullers to take the grease out of their cloth before they apply soap. It is essential to fullers earth that the particles of silica be very fine, otherwise they would cut the cloth. Any clay, possessed of this last property, may be considered as *fullers earth*; for it is the alumina alone which acts upon the cloth, on account of its strong affinity for greasy substances.

120
G. II. Co-
lorific
earths.

GENUS II. COLORIFIC EARTHS.

The minerals belonging to this genus consist of clay, mixed with so large a quantity of some colouring ingredient as to render them useful as paints. The colouring matter is commonly oxide of iron, and sometimes charcoal.

121
Red chalk.

SPECIES 1. Red chalk. *Reddle.*

Texture earthy. Fracture conchoidal. Lustre o. Opaque. Hardness 4. Sp. gr. inconsiderable. Colour dark red.

Feels rough. Stains the fingers. Adheres to the tongue. Falls to powder in water. Does not become ductile. When heated it becomes black, and at 159° Wedgewood melts into a greenish yellow frothy enamel. Composed of clay and oxide of iron.

122
Yellow
chalk.

SPECIES 2. Yellow chalk.

Texture earthy. Fracture conchoidal. Hardness 3. Sp. gr. inconsiderable. Colour ochre yellow.

Feels smooth or greasy. Stains the fingers. Adheres to the tongue. Falls to pieces in water. When heated becomes red; and at 156° Wedgewood melts into a brown porous porcelain.

According to Sage, it contains
50 alumina,
40 oxide of iron,
10 water, with some sulphuric acid.

* Mem.
Par. 1779,
313.
123
Black
chalk.

SPECIES 3. Black chalk.

Structure slaty. Texture earthy. Fragments splintery. Lustre o. Opaque. Hardness 5. Sp. gr. 2.144 to 2.277. Colour black. Streak black.

Feels smooth. Adheres slightly to the tongue. Does not moulder in water. When heated to redness it becomes reddish grey.

According to Wiegand, it is composed of
64.50 silica,
11.25 alumina,
11.00 charcoal,
2.75 oxide of iron,
7.50 water.

97.00 †

† Ann. de
Chim. xxx.

13.
124
Green
earth.

SPECIES 4. Green earth.

Texture earthy. Lustre o. Opaque. Hardness 6 to 7. Sp. gr. 2.637. Colour green.

Commonly feels smooth. Does not stain the fingers. Often falls to powder in water. When heated it becomes reddish brown; and at 147° Wedgewood melts into a compact glass.

Composed of clay, oxides of iron, and nickel.

125
G. III. Marl.

GENUS III. MARL.

A mixture of carbonate of lime and clay, in which the

carbonate considerably exceeds the other ingredient, is called *marl*.

Its texture is earthy. Lustre o. Opaque. Hardness from 4 to 8; sometimes in powder. Sp. gr. from 1.6 to 2.877. Colour usually grey, often tinged with other colours. Effervesces with acids.

Some marls crumble into powder when exposed to the air; others retain their hardness for many years.

Marls may be divided into two species: 1. Those which contain more silica than alumina; 2. Those which contain more alumina than silica. Mr Kirwan has called the first of these *siliceous*, the second *argillaceous*, marls. Attention should be paid to this distinction when marls are used as a manure.

126
G. IV.
Mould.

GENUS IV. MOULD.

By *mould* is meant the soil on which vegetables grow.

It contains the following ingredients: silica, alumina, lime, magnesia (sometimes), iron, carbon derived from decayed vegetable and animal substances, carbonic acid, and water. And the good or bad qualities of *soils* depends upon a proper mixture of these ingredients. The silica is seldom in the state of an impalpable powder, but in grains of a greater or smaller size: Its chief use seems to be to keep the soil open and pervious to moisture. If we pass over the carbon, the iron, and the carbonic acid, the goodness of a soil depends upon its being able to retain the quantity of moisture which is proper for the nourishment of vegetables, and no more. Now the retentive power of a soil increases with the proportion of its alumina, lime, or magnesia, and diminishes as the proportion of its silica increases. Hence it follows, that in a dry country, a fertile soil should contain less silica, and more of the other earths, than in a wet country.

Giobert found a fertile soil near Turin, where it rains annually 30 inches, to contain

From 77 to 79 silica,
9 — 14 alumina,
5 — 12 lime.

Near Paris, where it rains about 20 inches annually, Mr Tillet found a fertile soil to contain

Coarse sand	25
Fine sand	21
—	46.0 silica,
	16.5 alumina,
	37.5 lime.

100.0 *

The varieties of mould are too numerous to admit an accurate description: we shall content ourselves, therefore, with mentioning the most remarkable.

* Kirwan
on Manures.

SPECIES 1. Sand.

This consists of small grains of siliceous stones not cohering together, nor softened by water. When the grains are of a large size, the soil is called *gravel*.

127
Sand.

SPECIES 2. Clay.

This consists of common clay mixed with decayed vegetable and animal substances.

128
Clay.

SPECIES 3. Loam.

Any soil which does not cohere so strongly as clay, but more strongly than chalk, is called *loam*. There are many varieties of it. The following are the most common.

129
Loam.

Variety

Order III.

MINERALOGY.

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Earths and
Stones.

Variety 1. Clayey loam; called also *strong, stiff, cold,*
and *heavy*, loam.

It consists of a mixture of clay and coarse sand.

Variety 2. Chalky loam.

A mixture of clay, chalk, and coarse sand; the chalk predominating.

Variety 3. Sandy loam.

A mixture of the same ingredients; the sand amounting to .8 or .9 of the whole.

130
Till.

SPECIES 4. Till.

Till is a mixture of clay and oxide of iron. It is of a red colour, very hard and heavy.

SECT II. *Aggregates of Amorphous Stones.*

THE aggregates which belong to this section consist of amorphous fragments of stones cemented together. They may be reduced to the following genera:

1. Sandstone,
2. Puddingstone,
3. Amygdaloid,
4. Breccia.

GENUS I. SANDSTONE.

Small grains of sand, consisting of quartz, flint, hornstone, siliceous shists, or feldspar, and sometimes of mica, cemented together, are denominated sandstones. They feel rough and sandy; and, when not very hard, easily crumble into sand. The cement or basis by which the grains of sand are united to each other is of four kinds; namely, lime, alumina, silica, iron. Sandstones, therefore, may be divided into four species.

SPECIES 1. Calcareous sandstones.

Calcareous sandstones are merely carbonat of lime or marl, with a quantity of sand interposed between its particles. Though the quantity of sand, in many cases, far exceeds the lime, calcareous sandstones are sometimes found crystallized; and, in some cases, the crystals, as might be expected, have some of the forms which distinguish carbonat of lime. Thus the calcareous sandstone of Fontainebleau is crystallized in rhomboidal tables. It contains, according to the analysis of Laffone

62.5 siliceous sand,
37.5 carbonat of lime.

100

Calcareous sandstones have commonly an earthy texture. Their surface is rough. Their hardness from 6 to 7. Their specific gravity about 2.5 or 2.6. Their colour grey; sometimes yellowish or brown. They are sometimes burned for lime.

133
Aluminous.

SPECIES 2. Aluminous sandstones.

The basis of argillaceous sandstones is alumina, or rather clay. Their structure is often slaty. Their texture is compact, and either fine or coarse grained, according to the size of the sand of which they are chiefly composed. Their hardness is from 6 to 8, or even 9. Their colour is usually grey, yellow, or brown.

They are often formed into mill-stones, filtering-stones, and coarse whet-stones.

134
Siliceous.

SPECIES 3. Siliceous sandstones.

Siliceous sandstones consist of grains of sand cemented together by silica, or some substance which consists chiefly of silica or flint. They are much harder than any of the other species.

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Sometimes stones occur, consisting of grains of lime aggregated together with silica. These stones are also denominated siliceous sandstones.

SPECIES 4. Ferruginous sandstones.

135
Ferruginous.

The iron which acts as a cement in ferruginous sandstones is not far from a metallic state. When iron is completely oxidated, it loses the property of acting as a cement. This is the reason that ferruginous sandstones, when exposed to the air, almost always crumble into powder.

The colour of ferruginous sandstones is usually dark red, yellow, or brown. The grains of sand which compose them are often pretty large. Their hardness is commonly inconsiderable.

GENUS II. PUDDING STONE.

136
G. II. Pudding stone.

Pebbles of quartz, flint, or other similar stones of a round or elliptical form, from the size of rape seed to that of an egg, cemented together by a siliceous cement, often mixed with iron, have been denominated *pudding stones*.

Pudding stones, of course, are not inferior in hardness to quartz, flint, chalcedony, &c. of which the pebbles may consist. The colour of the cement is usually yellow, brown, or red. Its fracture is conchoidal.

The finer sorts of pudding stones are capable of a fine polish; the coarse are used for mill-stones.

GENUS III. AMYGDALOID.

137
G. III. Amygdaloid.

Rounded or elliptical masses of chalcedony, zeolite, limestone, lithomarga, steatites, green earth, garnets, hornblende, or opal, cemented together by a basis of indurated clay, trap, mullen, walken or kragg, constitute an *amygdaloid*.

Amygdaloids are opaque. They have no lustre. Their fracture is uneven or conchoidal. Hardness 6 to 9. Their colours are as various as the ingredients of which they are composed.

GENUS IV. BRECCIA.

138
G. IV. Breccia.

Angular fragments of the same species of stone, agglutinated together, constitute a *breccia*. This calcareous breccia consists of fragments of marble cemented together by means of lime.

SECT. III. *Aggregates of Crystals.*

THE minerals belonging to this section consist either of crystals of different kinds cemented together, or of crystals and amorphous stones cemented together.

They may be reduced under the following genera.

1. Granite,
2. Sienite,
3. Granatine,
4. Granitell,
5. Granilite,
6. Trap,
7. Porphyry.

GENUS I. GRANITE.

139
G. I. Granite.

An aggregate of feldspar, quartz, and mica, whatever be the size or the figure of the ingredients, is denominated *granite*. This aggregate may be divided into two species, namely, *common granite*, and *schistose granite* or *gneiss*.

SPECIES 1. Common granite.

Its structure is always granular. The feldspar is often amor.

140
Common.

Earths and
Stones.

amorphous, and constitutes most frequently the greatest part of the aggregate.

Common granites differ much in their appearance, according to the size, proportion, colour, and figure of their component parts. They are commonly very hard: Their specific gravity varies from 2.5388 to 2.9564.

141
Gneiss.

SPECIES 2. Shistose granite or gneiss.

The structure of gneiss is always slaty, and this constitutes its specific character. In gneiss, the proportion of quartz and felspar is nearly equal: the proportion of mica is smallest. It is evidently subject to the same varieties with common granite.

142
G II. Sienite.

GENUS II. Sienite.

Mr Werner has given the name of *sienite* to aggregates composed of felspar, hornblende, and quartz; or of felspar, hornblende, quartz, and mica. These aggregates were formerly confounded with quartz.

Sienite is found both of a granular and slaty structure: it might, therefore, like granite, be divided into two species. In sienite the quartz is commonly in by far the smallest proportion.

143
G. III. Granatine.

GENUS III. GRANATINE.

Mr Kirwan has applied the name *granatine* to the following aggregates.

Quartz, Felspar, Shorl.	Quartz, Mica, Garnet.	Quartz, Hornblende, Jade.	Felspar, Mica, Shorl.
Quartz, Felspar, Jade.	Quartz, Shorl, Hornblende.	Quartz, Hornblende, Garnet.	Felspar, Mica, Hornblende.
Quartz, Felspar, Garnet.	Quartz, Shorl, Jade.	Quartz, Jade, Garnet.	Felspar, Quartz, Serpentine.
Quartz, Mica, Shorl.	Quartz, Shorl, Garnet.	Quartz, Hornblende, Hornstone.	Felspar, Quartz, Steatites.
Quartz, Mica, Jade.			

One of these aggregates, namely, quartz, mica, garnet, was called by Cronstedt *morka* or *murksten*.

144
G. IV. Granitell.

GENUS IV. GRANITELL.

Mr Kirwan gives the name of *granitell* to all aggregates composed of any two of the following ingredients: quartz, felspar, mica, shorl, hornblende, jade, garnet, steatites. The most remarkable of these are:

Quartz, Felspar.	Quartz, Hornblende.	Quartz, Steatites.	Felspar, Hornblende.
Quartz, Mica.	Quartz, Jade.	Felspar, Mica.	Felspar, Jade.
Quartz, Shorl.	Quartz, Garnet.	Felspar, Shorl.	Felspar, Garnet.

Mica, Shorl.	Mica, Jade.	Hornblende, Jade.	Jade, Garnet.
Mica, Hornblende.	Mica, Garnet.	Hornblende, Garnet.	Steatites, Shorl.

Aggregates.

Some of these aggregates have received particular names. The aggregate of quartz and mica, when its structure is slaty, is called by Werner *shistose mica*: by the Swedes, it is denominated *fljelfsten*, whatever be its structure.

The aggregate of hornblende and mica is called *grunflein*, from the dark green colour which it usually has.

GENUS V. GRANILITE.

Under the name of *granilite*, Mr Kirwan comprehends all aggregates containing more than three ingredients. Of these the following are the most remarkable.

Quartz, Felspar, Mica, Shorl.	Quartz, Mica, Shorl, Garnet.	Quartz, Sulph. of barytes, Mica, Shorl.
Quartz, Felspar, Mica, Steatites.	Quartz, Felspar, Mica, Garnet.	Quartz, Sulph. of barytes, Mica, Hornblende.

GENUS VI. TRAP (P).

Under this genus we class not only what has commonly been called *trap*, but also wacken, and mullen, and kragstone of Kirwan.

SPECIES I. Common trap.

This stone is very common in Scotland, and is known by the name of *whinstone*. Whole hills are formed of it; and it occurs very frequently in large rounded detached fragments. Sometimes it assumes the form of immense columns, and is then called *basalt*. The Giants Causeway in Ireland, the island of Staffa, and the south side of Arthur's Seat in Scotland, are well known instances of this figure.

Its texture is earthy or compact. Its fracture uneven. Its lustre commonly o. Opaque. Hardness 8 to 9. Not brittle. Sp. gr. from 2.78 to 3.021 * Colour black, with a shade of grey, blue, or purple; sometimes blackish or reddish brown; in some cases greenish grey. By exposure to the atmosphere, it often becomes invested with a brownish rind. Before the blow-pipe, it melts *per se* into a more or less black glass.

Trap consists of small crystals of hornblende, felspar, olivine, &c. usually set in a ground composed apparently of clay and oxide of iron. A specimen, in the form of basalt, from Staffa, analysed by Dr Kennedy of Edinburgh, contained

48 silica,
16 alumina,
16 oxide of iron,
9 lime,
5 moisture,
4 soda,
1 muriatic acid.

99 †

† Edin.
A Transf. v.
89.

(P) Kirw. I. 231 and 431.—Faujas de St Fond. *Essai sur l'Hist. Nat. des Roches de Trap*.—Phil. Transf. passim. See also a very ingenious set of experiments on the fusion of trap, by Sir James Hall in *Transf. Edin.* V. 43.

Earths and Stones. A specimen from Salisbury rock, near Edinburgh, contained, according to the analysis of the same gentleman,

46.0 silica,
19.0 alumina,
17.0 oxide of iron,
8.0 lime,
4.0 moisture,
3.5 soda,
1.0 muriatic acid.

98.5 *

Dr Kennedy conducted these analyses with great ingenuity and judgment; and the discovery in which they terminated, that trap contains soda, is certainly of importance, and may lead to valuable consequences both in a geological and mineralogical view.

148
Wacken.

SPECIES 2. Wacken †.

† Kirwan, This stone often forms considerable parts of hills, and like trap, is amorphous. Its texture is earthy. Its fracture usually even. Lustre o. Opaque. Hardness 6 to 9. Sp. gr. from 2.535 to 2.893 ‡. Colour grey, with a shade of green, black, red, brown. When exposed to the atmosphere, it withers and becomes more grey.

It melts into a grey porous slag.

149
Mullen.

SPECIES 3. Mullen *.

* Kirwan, This stone is also found in considerable masses, and sometimes has a tendency to a columnar form like basalt. Texture earthy. Fracture uneven, and fine splintery. Lustre o, except from some shining particles of basaltine. Opaque. Hardness from 7 to 9. Sp. gr. from 2.6 to 2.738. Colour ash or bluish grey; sometimes mixed with ochre yellow, in consequence of the decomposition of the stone. At 130° Wedgewood it melts into a black compact glass.

When mullen is exposed to the air, its surface becomes covered with a greyish white rind sometimes slightly ochry.

150
Kragstone.

SPECIES 4. Kragstone *.

* Kirw. i. This stone, which, like the others, forms considerable parts of rocks, was formed into a distinct species by Mr Kirwan. Its texture is earthy. It is exceedingly porous, and the pores are often filled with the crystals of other minerals. Fracture uneven. Lustre o. Opaque. Hardness 5 to 7. Sp. gr. 2.314. Feels rough and harsh. Colour reddish grey. Streak yellowish grey. At 138° Wedgewood it melts into a reddish brown porcelain mass.

151
G. VII.
Porphyry.

GENUS VII. PORPHYRY.

Any stone which contains scattered crystals or grains of felspar, visible to the naked eye, is denominated a *porphyry*. Besides felspar, porphyries generally contain small crystals of quartz, hornblende, and mica. These crystals are usually of a different colour from the stone in which they are found, and they are stuck in it as in a cement. It is evident from this definition, that the number of porphyries must be great. Each species receives its name from the stone which forms its basis. To describe them would be unnecessary. We shall only give a catalogue of the principal species.

1. Hornstone porphyry.
2. Pitchstone porphyry.
3. Hornslate porphyry.
4. Felspar or petunse porphyry.
5. Clay porphyry.
6. Hornblende porphyry.
7. Trap porphyry.

8. Wacken porphyry.
9. Mullen porphyry.
10. Krag porphyry.
11. Argillitic porphyry.
12. Potstone porphyry.
13. Serpentine porphyry.
14. Sandstone porphyry.

Aggregate.

The aggregates belonging to this section compose most of the mountains of the globe. In giving an account of them, we have adhered implicitly to the arrangement most generally received by mineralogists. It must be acknowledged, that this arrangement is by no means complete, and that some of the genera are too vague to be of much use. The number of aggregates already discovered is too great for giving to each a particular name. Perhaps it would be better henceforth to adopt the method proposed by Mr Hauy, namely, to constitute the genera from that ingredient which enters most abundantly into the aggregate, and which forms as it were its basis, and to distinguish the species according to the nature and proportion of the other ingredients. According to this plan, the aggregates hitherto discovered have been divided by Hauy into the following genera:

- | | |
|---------------------|--------------------------|
| 1. Felspathic rock. | 7. Hornblendean rock. |
| 2. Quartzous rock. | 8. Petro-filiceous rock. |
| 3. Micaceous rock. | 9. Garnetic rock. |
| 4. Chloritous rock. | 10. Calcareous rock. |
| 5. Serpentine rock. | 11. Argillaceous rock. |
| 6. Trappean rock. | 12. Corneous rock. |

SECT. IV. Volcanic Aggregates.

AGGREGATES formed by volcanoes may be reduced to the following genera.

1. Lava.
2. Tufa.
3. Pumice.
4. Athes.

GENUS I. LAVA.

All substances which have issued out of a volcano in a state of fusion are called *lavas*. They have been divided into three species.

SPECIES 1. Vitreous lava.

Found in small pieces.

Texture glossy. Fracture conchoidal. Lustre 3. Transparency from 3 to 1. Hardness 9 to 10. Sp. gr. from 2 to 3. Colour blackish, greenish, or whitish. Commonly somewhat porous.

SPECIES 2. Cellular lava.

This species is full of cells. Surface rough and full of cavities. Texture earthy. Lustre o. Opaque. Hardness 7 to 9. Sp. gr. varies, but does not exceed 2.8. Colour brown or greyish black. Commonly somewhat magnetic.

SPECIES 3. Compact lava.

This species is the most common of all; it runs into

F f 2

the

152
G. I. Lava.

153
Vitreous.

154
Cellular.

155
Compact.

the second by insensible degrees; and indeed is seldom found of any considerable size without some pores. It bears in general a very strong resemblance to trap.

A specimen of the lava of Catania in Sicily, analysed by Dr Kennedy, contained

51.0 silica,
19.0 alumina,
14.5 oxide of iron,
9.5 lime,
4.0 soda,
1.0 muriatic acid.

* *Transf.*
Edin. v.
93.

A specimen of the lava of Sta. Venere in Sicily he found to contain

99.0 *
50.75 silica,
17.50 alumina,
14.25 oxide of iron,
10.00 lime,
4.00 soda,
1.00 muriatic acid.

† *Ibid.* 94.

97.5 †

Thus we see, that the resemblance between trap and lava holds not only in their external appearance, but also in their component parts.

GENUS II. PUZZOLANA.

Found in small pieces. Surface rough. Texture earthy and porous. Fracture uneven. Lustre o. Opaque. Hardness 3. Very brittle. Sp. gr. from 2.57 to 2.8. Colour brown or dark grey. Magnetic. Easily melts into a black slag.

When mixed with lime into a mortar, it possesses the property of hardening even under water. This property it owes most probably, as Mr Kirwan supposes, to the iron which it contains. The iron decomposes the water of the mortar, and by this means it becomes too hard to be acted upon by water in a very short time.

GENUS III. PUMICE.

This is a very light substance ejected from volcanoes. It is porous. Hardness 3. Brittle. Sp. gr. below 1. Colour grey or brown.

In some varieties the lustre and transparency are 0: in others, the lustre is glassy, 2. Transparency from 1 to 2.

GENUS IV. VOLCANIC ASHES.

These are analogous to the ashes of common pit coal. Loose and smooth, very light and fine. Slowly diffusible in water, and when wet somewhat ductile.

CLASS II. SALTS.

UNDER this class we comprehend all the combinations of alkalis with acids which exist in the mineral kingdom. As they have been already described in the article CHEMISTRY, *Suppl.* we shall here only give a list of their names.

GENUS I. POTASS.

Sp. 1. Sulphat of potash.
2. Nitrat of potash.

GENUS II. SODA.

Sp. 1. Carbonat of soda.
2. Sulphat of soda.
3. Muriat of soda.
4. Borax.

GENUS III. AMMONIA.

Sp. 1. Sulphat of ammonia.
2. Muriat of ammonia.

CLASS III. COMBUSTIBLES.

THE combustible substances belonging to the mineral kingdom, excluding the metals, may be comprehended under the following genera.

1. Sulphur.
2. Carbon.
3. Bitumen.
4. Coal.
5. Amber.

GENUS I. SULPHUR.

SPECIES 1. Native sulphur.

This substance is found abundantly in many parts of the world, especially near Volcanoes, as Hecla, Aetna, Vesuvius, the Lipari islands, &c. It is either in the state of powder, or massive, or crystallized. The primitive form of its crystals is an octohedron, composed of two four-sided pyramids, joined base to base †. The sides of these pyramids are scalene triangles, and so inclined that the plane where the bases of the pyramids join in a rhomb, whose long diagonal is to its short as 5 to 4 ‡. Sometimes the apices of the pyramids, to use the language of De Lisle, are truncated; sometimes they are separated from each other by a prism;

sometimes they are truncated near their bases, and a low four-sided pyramid rises from the truncature: this pyramid is also sometimes truncated near its apex ¶. Finally, one of the edges of the pyramids is sometimes truncated. For figures of these varieties and for the laws of their formation, we refer to *Mr Lefroy* *.

Colour yellow, with a shade of green; sometimes reddish (Q). Lustre greasy, 2. Transparency varies from 0 to 4. Causes double refraction †. Texture compact. Hardness 4 to 5. Brittle.—For its other properties, we refer to CHEMISTRY in this *Suppl.*

Sometimes sulphur is mixed with different proportions of earths. These combinations are hardly susceptible of accurate description.

Sulphur combines also with metals. These combinations shall be described in the fourth class.

GENUS II. CARBON.

This genus comprehends all minerals composed of pure carbon, or of carbon combined with a little earth.

SPECIES 1. Diamond.

This mineral, which was well known to the ancients,

160
Genera.

161
G. I. Sulphur.

‡ Fig. 34.

‡ *Romé de Lisle*, i. 292.
Haüy and *Lefroy*,
Jour. de Min. N^o xxix. 337.

Combustible.

157
G. III. Pumice.

158
G. IV. Volcanic ashes.

* *Jour. de Min.* N^o xxix. 337.
† *Haüy*.

162
G. II.

163
Diamond.

(Q) It then contains arsenic.

Combustibles.

is found in different parts of Asia, particularly in the kingdoms of Golconda and Visapour; it is found also in Brazil.

† Fig. 36.

It is always crystallized; but sometimes so imperfectly, that at the first sight it might pass for amorphous. Its primitive form is a regular octagon †; but it more commonly assumes a spheroidal form, and then has usually 36 curvilinear triangular faces, six of which are raised upon each of the faces of the primitive octagon †. Its integrant molecule, according to Haüy, is a regular tetrahedron.—For a more particular account of the crystals of this mineral, we refer the reader to *Mr Romé de Lisle* * and *Mr Haüy* †.

* *Crystall.* ii. 191.† *Four. de Min.* N°

xxix. 343.

† *Haüy, ibid.*

Texture foliated. Lustre 4. Transparency from 2 to 4. Causes single refraction. Hardness 20. Sp. gr. 3.5185 to 3.5310 †. Colour various; sometimes limpid, sometimes red, orange, yellow, green, blue, and even blackish.

When rubbed it becomes positively electric, even before it has been cut by the lapidary, which is not the case with any other gem †.

† *Id. ibid.*§ *Morveau,**Ann. de**Chim.* xxxi.

72.

164

Mineral

charcoal.

SPECIES 2. Mineral charcoal.

Kilkenny coal—Wales culm.

This mineral has been found in Hungary, Italy, France, Ireland, and Wales. It occurs in stratified masses, or in lumps nested in clay.

Colour black. Lustre 4, metallic. Opaque. Texture foliated. Hardness 5 to 7. Sp. gr. 1.4 to 1.526. Often stains the fingers. Insoluble in acids. Deflagrates with nitre. Does not burn till wholly ignited, and then consumes slowly without emitting flame or smoke.

It consists almost entirely of charcoal, which, as Morveau has proved, is an oxide of carbon *.

* *Ibid.*

165

Anthracite.

SPECIES 3. Anthracite (R).

Anthracolite.

This substance, as Dolomieu informs us, is found exclusively in the primitive mountains. It is always amorphous. Colour black or brownish black. Lustre 3 to 4. Structure slaty. Fragments rhomboidal. Hardness 6 to 7. Sp. gr. greater than that of coal. Often stains the fingers.

Burns precisely like the last species, and leaves .40 of white ashes. According to Dolomieu, it is composed of about

64.0 charcoal,

32.5 silica,

3.5 iron,

100.0 †

† *Four. de**Min.* N°

xxix. 338.

It is probable that the charcoal in the two last substances is in the same state in which it exists in plumbago, combined with oxygen, but not containing so much as charcoal does †.

† *Morveau,**ibid.*

GENUS III. BITUMEN.

By bitumen we understand, with mineralogists in general, an oil, which is found in different parts of the earth, in various states of consistence. These different states form distinct species; in our arrangement of which we shall be guided by the observations which Mr Hatchett has made in his valuable paper on bituminous substances *.

* *Nicholson's**Journal,* ii.

201, 248.

SPECIES 1. Naphtha.

This substance is found sometimes on the surface of the water of springs, and sometimes issuing from certain strata. It is found in great abundance in Persia.

It is as fluid and transparent as water. Colour white or yellowish white. Smell strong, but not disagreeable. Sp. gr. when white, .708 * or .729 †; when yellowish, .8475 †. Feels greasy. Catches fire on the approach of flame, burns with a white flame, and leaves scarce any residuum.

Insoluble in alcohol. Does not freeze at 0° Fahrenheit. When pure naphtha is exposed to the air, it becomes yellow and then brown; its consistence is increased, and it passes into petroleum *.

SPECIES 2. Petroleum.

This substance is also found in Persia, and likewise in many countries in Europe, particularly Italy, France, Switzerland, Germany, Sweden, England, and Scotland.

Not so fluid nor transparent as water. Colour yellow, either pale or with a shade of red or green; reddish brown and reddish black. Smell that of naphtha, but less pleasant. Sp. gr. 8783 *. When burned it yields a foot, and leaves a small quantity of coaly residuum.

By exposure to the air it becomes like tar, and is then called *mineral tar* †.

SPECIES 3. Mineral tar.

This substance is found in many parts of Asia, America, and Europe. It is viscid, and of a black, brownish black, or reddish colour. Smell sometimes strong, but often faint. Sp. gr. 1.1. When burned, emits a disagreeable bituminous smell. By exposure to the air it passes into *mineral pitch* and *maltha* *.

SPECIES 4. Mineral pitch and maltha.

This substance has a strong resemblance to common pitch. When the weather is warm it is soft, and has some tenacity; it is then called *adhesive mineral pitch*; when the weather is cold, it is brittle; its hardness is 5; and its fracture has a glassy lustre. In this state it is called *maltha*. Colour black, dark brown, or reddish. Lustre 0. Opaque. Sp. gr. from 1.45 to 2.07. Does not stain the fingers. On a white hot iron it flames with a strong smell, and leaves a quantity of grey ashes. It is to the presence of the earths which compose these ashes that the great specific gravity of this bitumen is to be ascribed. By farther induration, it passes into *asphalt*.

SPECIES 5. Asphalt.

This substance is found abundantly in many parts of Europe, Asia, and America, especially in the island of Trinidad.

Colour black or brownish black. Lustre greasy 2. Opaque. Fracture conchoidal, of a glassy lustre. Hardness from 7 to 8. Very brittle. Sp. gr. 1.07 to 1.165 *. Feel smooth, but not greasy. Does not stain the fingers. Has little or no smell, unless when rubbed or heated. When heated melts, swells, and inflames; and when pure, burns without leaving any ashes.

SPECIES 6. Elastic bitumen.

Mineral caoutchouc.

This substance was found about the year 1786 in the lead

Combustibles.

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Naphtha.

167

Naphtha.

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Naphtha.

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Naphtha.

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Naphtha.

Combustibles.

lead mine of Odin, near Castletown, Derbyshire. It was first mentioned by Mr De Born.

Colour yellowish or reddish brown, sometimes blackish brown. In its appearance it has a strong resemblance to caoutchouc or Indian rubber; hence its name. Consistency various: sometimes so soft as to adhere to the fingers; sometimes nearly as hard as asphalt. When soft it is elastic; when hard brittle. Sp. gr. 0.9053 to

* Hatchett, 1.0233*.
ibid.

Insoluble in alcohol, ether, and oil of turpentine, but soluble in oil of olives. Not affected by nitric acid. When distilled, it yields a bituminous oil insoluble in alcohol; the residuum is carbonaceous†.

† Lameth-
rie, Jour. de
Phys. xxxi.
312.

There is a variety of this substance found in a rivulet near the mine of Odin, which, when fresh cut, exactly resembles fine cork in colour and texture; but in a few days after being exposed to the air, becomes of a pale reddish brown. This substance contains within it a nucleus of elastic bitumen. It seems to be the elastic bitumen altered in its texture by the water‡.

‡ Hatchett,
ibid.

173
G. IV. Coal.

GENUS IV. COAL.
The substances belonging to this genus are composed of carbon, or rather charcoal, and bitumen.

174
Jet.

SPECIES 1. Jet (s).

This substance is found in France, Spain, Germany, Britain, and other countries. It is found in detached kidneyform masses, of various sizes, from an inch to seven or eight feet in length.

Colour full black. Lustre 3 to 4; internal glassy. Opaque. Hardness 7 to 8. Not near so brittle as asphalt. Texture striated. Fracture conchoidal. Sp. gr. 1.259*. It has no odour except when heated, and then it resembles the odour of asphaltum. Melts in a strong heat, burns with a greenish flame, and leaves an

* Briffon.

† Hatchett.

earthy residuum‡. Becomes somewhat electric by friction‡. When

‡ Kirwan.

§ Vauquelin.

distilled yields a peculiar acid§. This mineral is formed into buttons, beads, and other trinkets. The manufacture has been almost confined to France||.

|| Jour. de
Min. N° iv.
41.

SPECIES 2. Cannel coal.

175
Cannel
coal.

This mineral is found in Lancashire, and in different parts of Scotland, where it is known by the name of *parrot coal*.

Colour black. Lustre common, 2. Opaque. Structure sometimes slaty. Texture compact. Fracture conchoidal. Hardness 5 to 8. Brittle. Sp. gr. 1.232 to 1.426. Does not stain the fingers.

Kindles easily, and burns with a bright white flame like a candle (τ), which lasts but a short time. It does not cake. It leaves a stony or footy residuum.

A specimen of Lancashire cannel coal, analysed by Mr Kirwan, contained

75.20 charcoal,
21.68 maltha,
3.10 alumina and silica.

¶ Mineral.
ii. 523.

99.98¶

A specimen of the slaty kind from Airshire, called *splent coal*, was composed of

47.62 charcoal,
32.52 maltha,
20.00 earths.

100.14*

* Ibid. 524

Cannel coal is susceptible of polish, and, like jet, is often wrought into trinkets.

SPECIES 3. Common coal.

176
Common
coal.

This very useful combustible is never found in the primitive mountains, but only in the secondary mountains, or in plains formed of the same materials with them. It is always in strata, and generally alternates with clay, sandstone, or limestone.

Colour black, more or less perfect. Lustre usually greasy or metallic, 2 to 4. Opaque. Structure generally slaty. Texture often foliated. Fracture various. Hardness 4 to 6. Sp. gr. 1.25 to 1.37. Usually stains the fingers. Takes fire more slowly, and burns longer, than the last species. Cakes more or less during combustion.

Of this species there are many varieties, distinguished in Britain by the names of caking coal, rock coal, &c. These are too well known to require any description.

Mr Kirwan analysed a variety of different kinds of coal: The result of his experiments may be seen by the following table.

Whitchaven coal.	Wigan.	Swansey.	Leicrem.	
57.0	61.73	73.53	71.43	charcoal.
41.3	36.7	23.14	23.37	maltha & asph.
1.7	1.57	3.33	5.20	earths†.
100.0	100.00	100.00	100.00	

† Mineral.
ii. 525.

SPECIES 4. Spurious coal.

177
Spurious
coal.

This mineral is generally found amidst strata of genuine coal. It is also called *parrot-coal* in Scotland.

Colour greyish black. Lustre 0 to 1. Structure usually slaty. Texture earthy. Hardness 7 to 8. Sp. gr. 1.5 to 1.6. Generally explodes, and bursts when heated.

Composed of charcoal, maltha, and asphalt, and above .20 of stony matter.

GENUS V. AMBER.

178
G. V. Amber.

SPECIES 1. Common amber.

This substance, called *eletrum* by the ancients, is found in different countries; but most abundantly in Prussia, either on the sea-shore, or under-ground at the depth of about 100 feet, reposing on *wood-coal*‡. It is in lumps of different sizes.

Colour yellow. Lustre 3 to 2. Transparency 2 to 4. Fracture conchoidal. Hardness 5 to 6. Sp. gr. 1.078 to 1.085. Becomes electric by friction.

If a piece of amber be fixed upon the point of a knife, and then kindled, it burns to the end without melting¶.

¶ Haüy.

By distillation it yields fuccinic acid.

CLASS

(s) It was called *gagathes* by the ancients, from the river Gages in Licia, near which it was found; *jayet* in French, *oxabache* in Spanish, *gagath* in German.

(τ) Hence it has been called *cannel coal*. *Candle*, in the Lancashire and Scotch dialect, is pronounced *cannel*.

THIS class comprehends all the mineral bodies, composed either entirely of metals, or of which metals constitute the most considerable and important part. It is from the minerals belonging to this class that all metals are extracted; for this reason they have obtained the name of *ores*.

179
Orders.

The metals hitherto discovered amount to 21; we shall therefore divide this class into 21 orders, allotting a distinct order for the ores of every particular metal.

Metals exist in ores in one or other of the four following states: 1. In a metallic state, and either solitary or combined with each other. 2. Combined with sulphur. 3. In the state of oxides. 4. Combined with acids. Each order therefore may be divided into the four following genera.

180
Genera.

- | | |
|----------------|------------|
| 1. Alloys, | 3. Oxides, |
| 2. Sulphurets, | 4. Salts. |

It must be observed, however, that every metal has not hitherto been found in all these four states, and that some of them are hardly susceptible of them all. Some of the orders therefore want one or more genera, as may be seen from the following table.

ORDER I. *Gold ores.*

1. Alloys.

ORDER II. *Silver ores.*

1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

ORDER III. *Platinum ores.*

1. Alloys.

ORDER IV. *Ores of mercury.*

1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

ORDER V. *Copper ores.*

1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

ORDER VI. *Iron ores.*

1. Alloys.
2. Sulphurets.
3. Carburets.
4. Silicated iron.
5. Oxides.
6. Salts.

ORDER VII. *Tin ores.*

1. Sulphurets.
2. Oxides.

ORDER VIII. *Lead ores.*

1. Sulphurets.
2. Oxides.
3. Salts.

ORDER IX. *Zinc ores.*

1. Sulphurets.
2. Oxides.
3. Salts.

ORDER X. *Antimonial ores.*

1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

ORDER XI. *Bismuth ores.*

1. Alloys.
2. Sulphurets.
3. Oxides.

ORDER XII. *Arsenic ores.*

1. Alloys.
2. Sulphurets.
3. Oxides.

ORDER XIII. *Cobalt ores.*

1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

ORDER XIV. *Nickel ores.*

1. Sulphurets.
2. Oxides.
3. Salts.

ORDER XV. *Manganese ores.*

1. Oxides.
2. Salts.

ORDER XVI. *Tungsten ores.*

1. Oxides.
2. Salts.

ORDER XVII. *Ores of molybdenum.*

1. Sulphurets.

ORDER XVIII. *Ores of uranium.*

1. Oxides.
2. Salts.

ORDER XIX. *Ores of titanium.*

I. Oxides.

ORDER XX. *Ores of tellurium.*

I. Alloys.

ORDER XXI. *Ores of chromium.*

I. Oxides.

ORDER I. GOLD ORES.

No metal perhaps, if we except iron, is more widely scattered through the mineral kingdom than gold¹⁸¹. Where found. Hitherto it has been found only in a metallic state; most commonly in grains, ramifications, leaves, or rhomboidal, octahedral, or pyramidal crystals. It is generally mixed with quartz, though there are instances of its having occurred in calcareous rocks. It is not uncommon also to find it disseminated through the ores of other metals; especially iron, mercury, copper, and zinc. The greatest quantity of gold is found in the warmer regions of the earth. It abounds in the sands of many African rivers, and is very common in South America and India. Europe, however, is not destitute of this metal. Spain was famous in ancient times for its gold mines, and several of the rivers in France contain it in their sands†. But the principal gold mines† *Reaumur, Mem. Par.* of Salzburg. Gold also has been discovered in Sweden and Norway, and more lately in the county of Wicklow in Ireland‡. *1718, p. 68. † Lloyd, Phil. Transf. 1796, p. 36. Mills, ibid. p. 38.—Nicholson's Journ. ii. 224.*

GENUS I. Alloys of gold.

SPECIES I. Native gold.

Native gold is never completely pure; it is alloyed with some silver or copper, and sometimes with iron. In the native gold found in Ireland, indeed, the quantity of alloy appears to have been exceedingly small. Its colour is yellow. Lustre metallic. Fracture hackly. Hardness 5. Sp. gr. from 12 to 9.

ORDER II. SILVER ORES.

SILVER is found most commonly in quartz, limestone, hornstone; or combined with the ores of other metals, most commonly with copper, antimony, zinc, cobalt, and lead. This last metal indeed is seldom totally destitute of silver.

GENUS I. Alloys of silver.

SPECIES I. Native silver*.

Native silver, so called because the silver is nearly in a state of purity, forms the principal part of some of the richest silver mines in the world. It is sometimes in small lumps; sometimes crystallized in cubes, hexahedrons, octahedrons, or dodecahedrons; sometimes in leaves, or threads, often so connected with each other as to resemble branches of trees, and therefore called *dendrites*. The silver in the famous mines of Potosi has this last form. When newly extracted, it is not unlike small branches of fir†.

The colour of native silver is white; often tarnished. Lustre metallic. Fracture hackly. Hardness 6. Malleable. Sp. gr. from 10 to 10.338.

The silver in this species is almost constantly alloyed with from .03 to .05 of some other metal, frequently gold or arsenic.

Silver.
185
Alloy of
silver and
gold.

SPECIES 2. Alloy of silver and gold.

Auriferous native silver.

This alloy is not uncommon in silver mines. Its colour is yellowish white. Its lustre metallic. Hardness 5. Malleable. Sp. gr. above 10.6. Dr. Fordyce found a specimen from Norway composed of

72 silver,
28 gold.

* Phil.
Transf.
1776, p.
532.

186
Alloy of
silver and
antimony.
† Kirwan,
ii. 110.
† Romé de
Lisle, iii.
461.
§ Haüy,
Jour. de
Min. N°
xxx. p. 473.
* Kirwan,
ibid.
† Opusc. ii.
415.
† Jour. de
Min. ibid

SPECIES 3. Alloy of silver and antimony †.

Antimoniated silver ore.

This alloy, which is found in the silver mines of Spain and Germany, is sometimes in grains or lumps, and sometimes crystallized in six-sided prisms, whose sides are longitudinally channelled †.

Its colour is white. Its lustre metallic. Hardness 10. Brittle. Sp. gr. from 9.4406 † to 10.* Texture foliated. Fracture conchoidal. Before the blow-pipe the antimony evaporates in a grey smoke, and leaves a brownish slag, which tinges borax green. If borax be used at first, a silver bead may be obtained.

This alloy was long supposed to contain arsenic. Bergman examined it, and found only silver and antimony † His analysis has been confirmed by the experiments of Vauquelin and Selb †. According to Selb, it is composed of 89 silver,

11 antimony.

100

A specimen analysed by Klaproth, contained

84 silver,
16 antimony.

100

Another specimen contained

76 silver,
24 antimony.

100 †

GENUS II. SULPHURETS OF SILVER.

SPECIES 1. Common sulphuret of silver *.

Vitreous silver ore.

† Beitrüge,
ii. 301.
187
G. II. Sul-
phurets.
Common
sulphuret of
silver.
* Kirwan,
ii. 115.

† Crystall.
iii. 441.

† Briffon.
|| Gellert.

This ore occurs in the silver mines of Germany and Hungary. It is sometimes in masses, sometimes in threads, and sometimes crystallized. Its crystals are either cubes or regular octohedrons, whose angles and edges are often variously truncated. For a description of the varieties produced by these truncatures, we refer the reader to Romé de Lisle †.

Its colour is dark bluish grey, inclining to black; often tarnished. Internal lustre metallic. Texture foliated. Fracture uneven. Hardness 4 to 5. May be cut with a knife like lead. Flexible and malleable. Sp. gr. 6.909 † to 7.215 || In a gentle heat the sulphur evaporates. Melts when heated to redness.

A specimen of this ore, analysed by Klaproth, contained

85 silver,
15 sulphur.

100 *

* Beitrüge,
i. 162.

SPECIES 2. Antimoniated silver ore *.

Sulphuret of silver with antimony and iron.

This ore, which occurs in Saxony and Hungary, seems to be sulphuret of silver contaminated with antimony and iron, and ought therefore, in all probability, to be considered merely as a variety of the last species. It is sometimes in masses, but more frequently crystallized in six-sided prisms, tables, or rhomboids; generally indistinct and accumulated together.

Its colour is iron grey; often tarnished. Its lustre metallic. Fracture uneven. Hardness 4 to 5. Brittle. Sp. gr. 7.208 †. Before the blow-pipe the sulphur and antimony exhale, leaving a bead, which may be freed from iron by fusion with nitre and borax.

A specimen of this ore, analysed by Klaproth, contained

66.5 silver,
12.0 sulphur,
10.0 antimony,
5.0 iron,
1.0 silica,
0.5 arsenic and copper.

95.0 †

SPECIES 3. Sulphuret of silver and copper ||

Cupriferous sulphurated silver ore.

This ore, which is found in the Korbolokinsk mountains in Siberia, was first described by Mr Renovantz. It is in amorphous masses, varying in size from that of the thumb to that of the fist.

Its colour is bluish grey like lead. Lustre metallic. Hardness 5 to 6. Brittle. Its powder, when rubbed on the skin, gives it a black colour and a leaden gloss. Before the blow-pipe the sulphuret of silver melts readily; that of copper with difficulty. This ore is composed of about

42 silver,
21 copper,
35 sulphur.

98

GENUS III. OXIDES OF SILVER.

SPECIES 1. Calciform silver ore *.

This ore was first described by Mr Widenman. It is sometimes in masses, sometimes disseminated through other minerals.

Its colour is greyish black. Its streak bright. Its lustre metallic. Its fracture uneven. Hardness 4 to 5. Brittle. Sp. gr. considerable. Effervesces with acids. Melts easily before the blow pipe. Froths with borax.

According to Selb, it contains 72.5 silver,
15.5 copper,
12.0 carbonic acid.

100.0

SPECIES 2. Red silver ore (u).

This ore is very common in several German silver mines. It occurs in masses, disseminated and crystallized. The primitive form of its crystals is a dodecahedron †, whose sides are equal rhombs, and which may be con-

Metallic
ores.

188

Antimoni-
ated silver
ore.

* Kirwan,
ii. 118.

† Gellert.

† Beitrüge,
i. 166.

189
Sulphuret
of silver
and copper.

* Kirwan,
ii. 121.

190
G. III.
Oxides.

Calciform
silver ore.

* Kirwan,
ii. 112.

191

Red silver
ore.

† Fig. 38.
con-

(u) Kirw. II. 122.—Scopoli de Minera Argenti, Rubra.—Sage, Jour. de Phys. XXXIV. 331. and XLI. 370; and Nouv. Jour. de Phys. II. 284.—Westrum, Jour. de Phys. XLIII. 291.—Klaproth, Beitrüge, I. 141.

Order IV.

MINERALOGY.

233

Silver, considered as a six-sided rhomboidal prism, terminated by three-sided summits*. Sometimes the prism is lengthened, and sometimes its edges, or those of the terminating summits, or both, are wanting. For a description and figure of these varieties, we refer to *De Lisle* † and *Hauy* ‡.

† *Ibid.* Its colour is commonly red. Streak red. External lustre metallic, internal common. Transparency from 3 to 1; sometimes opaque. Fracture flat conchoidal. Hardness 5 to 7. Brittle. Sp. gr. from 5.44 || to 5.592*. Becomes electric by friction, but only when insulated †. Soluble in nitric acid without effervescence ‡. Before the blow-pipe melts, blackens, burns with a blue flame, gives out a white smoke with a slight garlic smell, and leaves a silver bead ||.

‡ *Hauy, ibid.* Variety 1. Light red. Colour intermediate between blood and cochineal red; sometimes variegated. Streak orange red. Powder black.

† *Hauy, ibid.* Variety 2. Dark red. Colour commonly between dark cochineal red and lead grey; sometimes nearly black, and without any shade of red. Streak dark crimson red.

This ore was long supposed to contain arsenic. Klaproth first ascertained its real composition*; and his analysis has been confirmed by Vauquelin, who found a specimen composed of 56.6748 silver, 16.1300 antimony, 15.0666 sulphur, 12.1286 oxygen.

100.

Klaproth proved, that the silver and antimony are in the state of oxides; and Vauquelin, that the sulphur is combined partly with the oxide of silver and partly with the oxide of antimony. Klaproth obtained a little sulphuric acid; but this acid, as Vauquelin, with his usual ingenuity, demonstrated, was formed during the analysis.

† *Vauquelin, ibid.* This ore sometimes contains a minute portion of arsenic, but never more than .02 †.

102
G. IV.
Salts.
Muriat of silver.

GENUS IV. SALTS OF SILVER.
SPECIES I. Muriat of silver (x).
Corneous silver ore.

This ore occurs at Johanngeorgenstadt in Saxony, in South America, &c. It is often amorphous, sometimes nearly in powder, and sometimes crystallized in cubes or parallelepipeds.

Its colours are various: when exposed to the light it becomes brown. Internal lustre greasy, 2; external, 2 to 1. Acquires a gloss when scraped with a knife. Transparency 2 to 1. Texture foliated. Hardness 4 to 5. Sp. gr. 4.745 † to 4.804 ||. Before the blow-

† *Briff. n.*
|| *Gellert.*

SUPPL. VOL. II. Part I.

pipe it instantly melts, and gradually evaporates, but may be reduced by adding an alkali.

That this ore contains muriatic acid, has been long known. Mr Woulfe first shewed that it contained also sulphuric acid*: and this discovery has been confirmed by Klaproth, according to whose analysis this ore is composed of

67.75 oxide of silver,
6.00 oxide of iron,
21.00 muriatic acid,
.25 sulphuric acid,
1.75 alumina.

96.75 †

The alumina can only be considered as mixed with the ore. Sometimes its quantity amounts to .67 of the whole ‡.

Metallic
ores.
* *Phil. Transf.*
1770.

† *Beiträge,*
1. 134.

‡ *Ibid.* p.
137.

ORDER III. ORES OF PLATINUM (γ).

HITHERTO no mine of platinum has been discovered. It is found in small scales or grains on the sands of the river Pinto, and near Carthagena in South America. It is always in a metallic state, and always combined with iron.

GENUS I. ALLOYS OF PLATINUM.

SPECIES I. Native platinum.

Its colour is whitish iron grey. Magnetic. Sp. gr. G. I. Alloys from 12 to 16. Soluble in nitro-muriatic and oxy-muriatic acids.

104

Native platinum.

ORDER IV. ORES OF MERCURY.

MERCURY is employed in medicine; it serves to separate silver and gold from their ores; the silvering of looking-glasses, gilding, &c. are performed by means of it; and its sulphuret forms a beautiful paint.

Mercury abounds in Europe, particularly in Spain, Germany, and Hungary: it is found also in China (z), the Philippines ||, and in Peru, and perhaps Chili (A) || *Carreri's Voyage.* In South America. The most productive mines of mercury are those of Idria*; of Almaden, near Cordova in Spain, which were wrought by the Romans (B) †; of the Palatinate ‡; and of Guanica Velica in Peru (C). xxxvi. p.

Mercury has never been found in Britain, nor has any mine worth working been discovered in France. It occurs most commonly in argillaceous shists, lime-stones, and sandstones.

GENUS I. ALLOYS OF MERCURY.

SPECIES I. Native mercury.

Native mercury is found in most mercurial mines: it is in small globules, scattered through different kinds of stones, clays, and ores.

Fluid. Colour white. Sp. gr. about 13.6.

G g

SPECIES

106.

G. I. Alloys
Native mercury.

- (x) *Kirw. II. 113.*—*Laxman. Nov. Comm. Petropol. XIX. 482.*—*Monnet, Mem. Sçav. Etang. IX. 717.*
(y) See *Brownrigg, Phil. Transf. XLVI. 584.*—*Lewis, ibid. XLVIII. 638.* and L. 148.—*Margraf, Mem. Berlin, 1757, p. 314.*—*Macquer, Mem. Par. 1758, p. 119.*—*Buffon, Jour. de Phys. III. 324.*—*Morveau, ibid. VI. 193.*—*Bergman, Opusc. II. 166.*—*Tillet, Mem. Par. 1779, p. 373,* and 385, and 545.—*Crell, Crell's Annals, 1784. 1 Band. 328.*—*Willis, Manchester Memoirs, III. 467.*—*Mussin Puschkin, Ann. de Chim. XXIV. 205.*—*Morveau, ibid. XXV. 3.*
(z) See *Entrecolle's Lettres Edificantes.*
(A) See *Molina's Natural History of Chili.*
(B) See *Bowle's Natural History of Spain,* and *Jour. de Min. N° xxxi. p. 555.*
(C) See *Ulloa's Memoirs concerning America.*

SPECIES 2. Amalgam of silver *.

Native amalgam.

197
Amalgam
of silver.
* Kirwan,
ii. 223.
† Cronstedt's
Min.
† Hoyer,
Cronst. An-
nals, 1790.

This mineral has been found in the silver mine of Sahlberg †, in the province of Dalecarlia, in Sweden; in the mines of Deux Ponts †, in the Palatinate; and in other places. It is in thin plates, or grains, or crystallized in cubes, parallelepipeds, or pyramids.

Its colour is silvery white or grey. Lustre metallic. Creaks when cut. Sp. gr. above 10. Tinges gold white. Before the blow-pipe the mercury evaporates and leaves the silver.

A specimen of this amalgam, analysed by Klaproth, contained
64 mercury,
36 silver.

§ Beitrage,
i. 183.

100 §

Sometimes it contains a mixture of alumina, and sometimes the proportion of mercury is so great that the amalgam is nearly as soft as paste.

198
G. II. Sul-
phurets
Common
sulphuret.
* Kirwan,
ii. 228.

GENUS II. SULPHURETS OF MERCURY.

SPECIES 1. Common sulphuret ||.

Native cinnabar.

This ore, which is found in almost all mercurial mines, is sometimes in veins, sometimes disseminated, sometimes in grains, and sometimes crystallized. The form of its crystals is a tetrahedron or three-sided pyramid, most commonly wanting the summit; sometimes two of these pyramids are joined base to base; and sometimes there is a three-sided prism interposed between them ¶.

Its colour is red. Its streak red and metallic. Lustre when crystallized 2 to 3; when amorphous, often 0. Transparency, when crystallized, from 1 to 3; when amorphous, often 0. Texture generally foliated. Hardness from 3 to 8. Sp. gr. from 5.419 to 10.128 §.

Before the blow-pipe evaporates with a blue flame and sulphureous smell. Insoluble in nitric acid *.

Variety 1. Dark red.

Colour cochineal red. Hardness 6 to 7. Sp. gr. when pure, 10.1285 †; sometimes only 7.2, or even 6.188 ‡.

Variety 2. Bright red.

Colour commonly scarlet. Sp. gr. 6.9022 § to 5.419 ||.

¶ Romé de
Lisfe, iii.
154.

* Haüy,
Jour. de
Min. N°
xxi. p.
518.
† Briffon.
‡ Muschen-
broek.
§ Briffon.
|| Gellert.

199
G. III.
Oxides.
Hepatic
mercurial
ore.

GENUS III. OXIDES OF MERCURY.

SPECIES 1. Hepatic mercurial ore ¶.

This ore, which is the most common in the mines of Idria, is always amorphous, and is often mixed with native mercury and cinnabar.

Its colour is somewhat red. Its streak dark red and brighter. Lustre commonly metallic. Hardness from 6 to 8. Sp. gr. from 9.2301 * to 7.186 †. When heated the mercury evaporates.

Though this ore has never been accurately analysed, chemists have concluded that the mercury which it contains is in the state of a red oxide, because it is insoluble in nitric and soluble in muriatic acid ‡. When purest, it contains about .77 of mercury §. It contains also some sulphur and iron.

Werner has divided this species into two varieties, the compact and the stony. The second is often nothing more than bituminous shale impregnated with oxide of mercury ||.

¶ Sage,
Jour. de
Phys. xxiv.
61.
§ Scopoli,
Jour. de
Min. N°
xxxvi. p.
919.
|| Kirwan,
ii. 226.

GENUS IV. MERCURIAL SALTS.

SPECIES 1. Muriat of mercury *.

Corneous mercury.

This ore, which occurs in the Palatinate, is sometimes in scales, sometimes in grains, and sometimes crystallized. Its crystals are either small four or six sided prisms whose sides are rhombs †, or cubes, or four-sided pyramids wanting their angles. They are always very small and generally confused.

Its colours are various; but it is most frequently white. Its lustre, when white, is pearly. Sometimes opaque, and sometimes semitransparent. Evaporates before the blow-pipe.

Mr Woulfe discovered that this ore generally contains some sulphuric acid ‡. Specimens have been found in which the quantity of sulphuric acid exceeds that of the muriatic §.

200
Mercurial
Salts.
Muriat of
mercury.
* Kirwan,
ii. 226.
† Romé de
Lisfe, iii.
161.

‡ Phil.
Trans. lxxi.
618.
§ Suckow.

ORDER V. COPPER ORES.

MANY of the most useful utensils are formed of copper: it enters largely into the composition of brads, bronze, and bell metal; not to mention the dyes and paints of which it is the basis.

Copper mines abound in most countries. They are wrought in China, Japan, Sumatra; the north of Africa; in Chili and Mexico; and in most parts of Europe; especially Britain, Germany, Russia, Hungary.

Copper is found most commonly in rocks of hornblende, schistus, and quartz.

GENUS I. ALLOYS OF COPPER.

SPECIES 1. Native copper ||.

Native copper occurs now and then in the greater number of copper mines: Sometimes it is in masses, sometimes in plates and threads, which assume a variety of forms; and sometimes, as in Siberia, it is crystallized in cubes, or other forms nearly resembling cubes §.

Colour commonly that of copper, but sometimes dark brown. Lustre metallic. Streak brighter. Fracture hackly. Flexible and malleable. Hardness 6 to 7. Sp. gr. from 7.6 * to 8.5844 †.

SPECIES 2. White copper ore ‡.

Alloy of copper, iron, and arsenic.

This ore, which is said to be uncommon, occurs in masses. Colour white. Lustre metallic. Fracture uneven. Hardness 8 to 9. Brittle. Sp. gr. considerable.

Before the blow-pipe gives out a white arsenical smoke, and melts into a greyish black slag §.

GENUS II. SULPHURETS OF COPPER.

SPECIES 1. Common sulphuret of copper ||.

Vitreous copper ore.

This ore, which is found in Cornwall, Hungary, and Siberia, occurs in masses, plates, threads, and crystallized in six-sided prisms, or four-sided pyramids, joined base to base.

Colour bluish grey. Streak brighter grey. Lustre metallic. Hardness 4 to 7. Sp. gr. 5.452 ¶ to 5.565 *; sometimes so low as 4.29 †. Detonates with nitre. ‡

Before the blow-pipe it melts easily; and while the fusion exhibits a green pearl, which, on cooling, is covered with a brown crust. Tinges borax green.

Werner makes two varieties of this ore: the first he calls

202
G. I. Alloys.
Native cop-
per.
* Kirwan,
ii. 127.
§ Cartheuser.

¶ Haüy,
Jour. de
Min. N°
xxi. 509.

* Kirwan,
Min. ii.
128.

† Haüy, ibid.
p. 509.

‡ Kir. Min.
ii. 152.

§ Widenman.

204
G. II. Sul-
phurets.
Copper.

Common
sulphuret of
copper.

¶ Kirwan,
ii. 144.

* Kirwan,
Gellert.

† Kirwan.

Copper
Ores.

calls *compact*, from its fracture; and the second, for the same reason, he calls *foliated*. This last is somewhat darker coloured than the first, but in other respects they agree.

SPECIES 2. Copper pyrites.
Yellow copper ore.

This ore, which is probably nothing else than sulphuret of iron combined with copper, and which, therefore, would be more properly placed among iron ores, is found frequently in copper mines, and mixed with common pyrites or sulphuret of iron. It is sometimes amorphous, and sometimes crystallized. Its crystals are either three or four sided pyramids applied base to base, or six-sided plates.

Its colour is yellow; often tarnished. Its internal lustre metallic. Hardness 6 to 7; sometimes 9. Brittle. Sp. gr. 4.314† to 4.68‡. Deflagrates; but does not detonate with nitre §.

Before the blow-pipe decrepitates, gives a greenish sulphureous smoke, and melts into a black mass, which tinges borax green. Does not effervesce with nitric acid.

SPECIES 3. Purple copper ore ||.

This ore is found in masses, or plates, or disseminated; sometimes, also, it is crystallized in octahedrons. Colour various, but most commonly purple; internally reddish. Streak reddish and bright. Lustre metallic. Hardness 6 to 7. Brittle. Sp. gr. 4.936 to 4.983¶. Effervesces with nitric acid, and tinges it green. Deflagrates with nitre. Before the blow-pipe melts readily, without smoke, vapour, or smell; but is not reduced. Tinges borax a bright green.

A specimen of this ore, analysed by Klaproth, contained

58 copper,
18 iron,
19 sulphur,
5 oxygen.

100†

SPECIES 4. Grey copper ore ‡.

This ore is found in Cornwall, Saxony, Hungary, &c. It is often amorphous, but often also crystallized. The primitive form of its crystals is the regular tetrahedron; but, in general, either the angles or the edges, or both, are truncated or bevelled §.

Colour steel grey; often tarnished, and then dark grey. Streak dark grey; sometimes reddish brown. Powder blackish; sometimes with a tint of red. Lustre metallic. Hardness 7 or 8. Very brittle. Sp. gr. 4.8648 ||. Deflagrates with nitre. Before the blow-pipe crackles, but at last melts, especially if assisted by borax. The bead gives a white smoke, without any particular smell; tinges borax yellow or brownish red, but does not unite with it.

A specimen of this ore from Cremonitz, analysed by Klaproth, contained

31 copper,
14 silver,
34 antimony,
3 iron,
11 sulphur.

93

Napion, in an ore from the valley of Lanzo, found copper, silver, and antimony, nearly in the same proportions, but more iron, and some arsenic*. Savorelli, as Baron Born informs us, besides the ingredients of Klaproth's analysis, found some gold and mercury in grey copper ore †: and Klaproth himself found lead in most of the other specimens which he examined.

GENUS III. OXIDES OF COPPER.

SPECIES 1. Red oxide of copper ‡.

Florid red copper ore—Red copper glass.

This ore is found in Cornwall, and many other countries. It occurs in masses, disseminated, in scales, and crystallized. The figure of its crystals is most commonly the octahedron §.

Colour commonly cochineal red. Streak brick red. Lustre semimetallic. Transparency, when amorphous, generally 0; when crystallized, 3 or 4. Hardness from 4 to 7. Soluble with effervescence in nitric acid. Before the blow-pipe melts easily, and is reduced.

This ore was supposed to be composed of carbonic acid and red oxide of copper; but a specimen, examined by Vauquelin, which consisted of pure crystals, contained no acid ||. It must therefore be considered as an oxide of copper.

Werner has made three varieties of this ore, which, from their texture, he has denominated *compact*, *foliated*, and *fibrous*. The first is seldom or never found crystallized, and is opaque; the second occurs amorphous, crystallized, and in scales; the third is carmine, ruby, or scarlet red; and occurs always in short capillary crystals, or delicate flakes.

This ore sometimes contains a mixture of red oxide of iron; it is then called *brick red copper ore*, *copper malm*, or *copper ochre*.

This ore is sometimes mixed with bitumen. Its colour is then brownish black, and it is called *pitch ore*.

SPECIES 3. Green oxide of copper*.

Green sand of Peru.

This ore, which was brought from Peru by Dombey, is a grass green powder, mixed with grains of quartz. When thrown on burning coals, it communicates a green colour to the flame. It is soluble both in nitric and muriatic acids without effervescence. The solution is green. It was supposed to contain muriatic acid †; but Vauquelin has discovered that the appearance of this acid was owing to the presence of some common salt, which is accidentally mixed with the sand ‡.

GENUS IV. SALTS OF COPPER.

SPECIES 1. Blue carbonat of copper (p).

Mountain blue—Azure de cuivre—Blue calx of copper—Kupfer lazur.

This ore, which occurs in the copper mines of Siberia, Sweden, Germany, Hungary, Cornwall, &c. is either amorphous or crystallized. The crystals are small, and difficult to examine. According to Romé de Lisse, their primitive form is an octahedron, the sides of which are isosceles triangles, and two of them more inclined than the others §. Be that as it may, the crystals of blue carbonat of copper are often rhomboidal prisms, either regular, or terminated by dihedral summits ||.

Its colour is azure or smalt blue. Streak blue. Hard-

G g 2

Metallic
Ores.* Mem. Tur.
rin, v. 173.† Catal. ii.
498.208
G. III.

Oxides.

Red oxide

of copper.

‡ Kirwan,

ii. 135.

§ Haüy,

Jour. de

Min. N^o

xxxi. 517.

|| Ibid.

209

Greenoxide

of copper.

* Kirwan,

ii. 149.

† Bertbollet,

Mem. Par.

1786, 462.

‡ Jour. de

Min. N^o

xxxi. 519.

210

G. IV. Salts.

Blue carbo-

nat of cop-

per.

§ Romé de

Lisse, iii.

345.

|| Haüy,

Jour. de

Min. N^o

xxxi. 512.

Copper
Ores.
† Briffon.

ness 4 to 6. Brittle. Sp. gr. 3.608 †. It effervesces with nitric acid, and gives it a blue colour. Before the blow-pipe it blackens, but does not melt. Tinges borax green with effervescence.

The crystals, according to Pelletier, are composed of
66 to 70 copper,
18 — 20 carbonic acid,
8 — 10 oxygen,
2 — 2 water.

Fontana first discovered that this ore contained carbonic acid gas.

Variety 1. Earthy blue carbonat.
Mountain blue.

This variety generally contains a mixture of lime. It is never crystallized; and sometimes is almost in the state of powder. Lustre o. Texture earthy.

Variety 2. Striated blue carbonat of copper.

Lustre glassy. Transparency, when crystallized, 2; when amorphous, 1. Texture striated; sometimes approaching to the foliated.

211
Green carbonat of copper.

SPECIES 2. Green carbonat of copper (E).
Oxygenated carbonat of copper—Malachite.

This ore is generally amorphous, but sometimes it is crystallized in four-sided prisms, terminated by four-sided pyramids.

* Briffon.
† Kirwan.

Colour green. Lustre silky. Hardness 5 to 7. Brittle. Sp. gr. 3.571* to 3.653 †. Effervesces with nitric acid, and gives a blue colour to ammonia. Before the blow-pipe it decrepitates and blackens, but does not melt. Tinges borax yellowish green. It is composed of carbonic acid and green oxide of iron.

Variety 1. Fibrous malachite.

Texture fibrous. Opaque when amorphous; when crystallized its transparency is 2. Colour generally grass green.

Variety 2. Compact malachite.

Texture compact. Opaque. Colour varies from the dark emerald green to blackish green.

A specimen of malachite from Siberia, analysed by Klaproth, contained

58.0 copper,
18.0 carbonic acid,
12.5 oxygen,
11.5 water.

* Beiträge,
ii. 290.

100 *

This species is sometimes mixed with clay, chalk, and gypsum, in various proportions; it is then known by the name of

Common mountain green.

Its colour is verdigris green. Lustre o. Transparency o to 1. Hardness 3 to 4. Brittle. Texture earthy. Effervesces feebly with acids. Before the blow-pipe it exhibits the same phenomena with malachite.

212
Sulphat of copper.

SPECIES 3. Sulphat of copper.

For a description of this salt, see CHEMISTRY, n° 648. in this Supplement.

213
Arseniat of copper.
† Kirwan,
ii. 151.

SPECIES 4. Arseniat of copper †.
Olive copper ore.

This ore is found at Cararach in Cornwall. It is generally crystallized in six-sided compressed prisms. Its colour is olive green. Streak sometimes straw coloured,

sometimes olive green. Lustre glassy. Transparency from 4 to 2. Fracture conchoidal. Hardness 4 to 7. Before the blow-pipe deflagrates with an arsenical smoke, and melts into a grey coloured bead. This bead, fused with borax, leaves a button of pure copper †.

Klaproth discovered that it was composed of oxide of copper and arsenic acid.

Sometimes this ore is combined with iron. It then crystallizes in cubes. These cubes are of a dark green colour; before the blow-pipe they frothe, give out an arsenical smoke, and do not so quickly form a grey bead as the arseniat of copper *.

† Klaproth's
Observations on
Cornwall,
p. 29.

* Ibid. p.
29.

ORDER VI. IRON ORES.

To describe the uses of iron, would be to write the history of every art and manufacture, since there is not one which is not more or less dependent upon this useful metal. Nor is its abundance inferior to its utility. It exists almost everywhere, and seems, as it were, the bond which connects the mineral kingdom together.

GENUS I. ALLOYS OF IRON.

SPECIES 1. Native iron (F).

Native iron has been found in Siberia and in Peru in immense masses, which seemed as if they had been fused. These masses evidently did not originate in the place where they were found. See FIRE-BALLS, Suppl.

Colour bluish white. Fracture hackly. Lustre metallic. Malleable. Magnetic. Hardness 8 to 9. Sp. gr. 7.8. Proust has discovered, that the native iron found in Peru is alloyed with nickel †.

GENUS II. SULPHURETS OF IRON.

SPECIES 1. Common sulphuret of iron *.

Pyrites.

This mineral occurs very frequently both in ores and mixed with other bodies, for instance in slates. It is often amorphous, and often also crystallized. The primitive form of its crystals is either a regular cube or an octohedron. The varieties of its form hitherto described amount to 30; for a description of which we refer the reader to *Romé de Lisle* †.

Its colour is yellow. Its lustre metallic. Hardness 8 to 10. Brittle. Sp. gr. 3.44 to 4.6. Soluble in nitric acid with effervescence. Scarce soluble in sulphuric acid. Before the blow-pipe burns with a blue flame and a sulphureous smell, and leaves a brownish bead, which tinges borax of a smutty green.

Variety 1. Common pyrites.

Fracture uneven. Hardness 10. Decrepitates when heated. Emits a sulphureous smell when rubbed. Not magnetic. It occurs often in coal mines and in slates.

Variety 2. Striated Pyrites.

Texture striated. Hardness 10. Not magnetic.

Variety 3. Capillary.

Colour often steel grey. Found in needle-form crystals. Uncommon. Not magnetic.

Variety 4. Magnetic pyrites.

Found in masses. Texture compact. Hardness 8, 9. Slightly magnetic. Seems to contain less sulphur than the other varieties.

In pyrites the proportion of the sulphur to the iron is variable; and this explains the variety of its crystalline forms.

GENUS

(E) Kirw. II. 131.—Fontana, *Jour. de Phys.* XI. 509.—Klaproth, *Beiträge*, II. 287.

(F) Pallas, *Phil. Transf.* LXVI. 523.—Rubin de Celis, *ibid.* LXVIII. 37.—See also Schreiber, *Jour. de Phys.* XLI. 3.; and Stelin, *Phil. Transf.* LXIV. 461.

Order IV.

MINERALOGY.

237

Iron Ore.

GENUS III. CARBURET OF IRON.

SPECIES 1. Plumbago *

Graphite of Werner.

This mineral is found in England, Germany, France, Spain, America, &c. It occurs in kidney-form lumps of various sizes. Its colour is dark iron grey or brownish black; when cut, bluish grey. Lustre metallic, from 3 to 4. Opaque. Structure flaty. Texture fine grained. Hardness 4 to 5. Brittle. Sp. gr. from 1.987 to 2.089; after being soaked in water 2.15; after being heated 2.3, and when heated after that 2.41 †. Feels somewhat greasy. Stains the fingers, and marks strongly. The use of this mineral when manufactured into pencils is known to every person.

† Briffon.

Its composition was discovered by Scheele. When pure it contains

90 carbon,
10 iron.

100

But it is often exceedingly impure: A specimen, for instance, from the mine of Pluffier, in France, analysed by Vauquelin, contained 23 carbon,

2 iron,
38 silica,
37 alumina.

100 †

GENUS IV. IRON COMBINED WITH SILICA.

SPECIES 1. Emery *

† Jour. de Min. N^o xii. p. 16. 218.
G. IV.
Emery.
* Kirwan,
ii. 193.

This mineral is commonly disseminated through other fossils, but sometimes in the East Indies it occurs in large masses.

Its colour is bluish grey, greyish brown, or bluish black, often covered with a yellowish rind; internally it discovers red or purple spots. Lustre 1 or 0; in some parts 2, and metallic. Opaque. Hardness 14. Brittle. Sp. gr. 3.92 †. Before the blow-pipe it blackens and gives a smutty yellow tinge to borax.

† Briffon.

According to Wiegleb it contains

95.6 silica,
4.3 iron.

99.9

GENUS V. OXIDES OF IRON.

This genus is very extensive; for iron is much more frequently found in the state of an oxide than in any other.

SPECIES 1. Black oxide of iron †.

Common magnetic iron stone—Blackish octohedral iron ore.

This species of ore is very common in Sweden; it is found also in Switzerland, Norway, Russia, &c. It occurs in masses, plates, grains, and crystallized. The primitive form of its crystals is a regular octohedron †. Sometimes two opposite sides of the pyramids are trapeziums, which renders the apex of the pyramids cuneiform. Sometimes the crystals pass into rhomboidal parallelopipeds, and into dodecahedrons with rhomboidal faces ‡.

Its surface is brownish black; internally bluish grey. Powder black *. Streak blackish grey, brighter. Lustre metallic. Hardness 9 to 10. Brittle. Sp. gr. from 4.094 to 4.688 †. Attracted by the magnet, and generally possessed of more or less magnetic virtue ‡. To

† Rome de Lisle, iii. 178.
§ Ibid.
* Haüy,
Jour. de Min. N^o xxxiii. 659.
† Kirwan's Min. ii. 159.
‡ Haüy,
Jour. de Min. N^o xxxi. 527.

this species belongs the magnet. Before the blow-pipe it becomes browner, but does not melt. Tinges borax dark green.

When pure it consists entirely of oxide of iron; and this oxide appears to contain from .15 to .24 oxygen, and from .76 to .85 iron ‡. Undoubtedly it consists of a mixture of iron in two different states of oxidation. It is often also mixed and contaminated with foreign ingredients.

There are two varieties of this ore. The first is what we have just described; the second is in the form of sand, and has therefore been called

Magnetic sand *.

This substance is found in Italy, Virginia, St. Domingo, the East Indies, and in the sand of the river Don at Aberdeen in Scotland. It is black, very hard, magnetic. Sp. gr. about 4.6. Not altered by the blow-pipe *per se*; melts into a black glass with potash, and into a green glass with microcosmic salt, both opaque †. It probably contains some silica, as Kirwan has supposed ‡.

SPECIES 2. Specular iron ore ¶.

Fer oligiste.

This ore is found abundantly in the isle of Elba near Tuscany. It is either in masses or crystallized. The primitive form of its crystals, and of its integrant molecules, is the cube *. The varieties hitherto observed amount to 7. These are the rhomboidal parallelopiped, the cube, with three triangular faces instead of two of its angles diagonally opposite; two six-sided pyramids, applied base to base, wanting the summits ‡, and sometimes the angles at the bases, and sometimes the alternate edges of the pyramid; a polyhedron of 24 sides, resembling a cube with three triangular faces for two angles diagonally opposite, and two triangles for the rest of its angles. For a description and figure of these varieties, we refer to *Romé de Lisle* † and *Haüy* ‡.

Colour steel grey; often tarnished, and beautifully iridescent, reflecting yellow, blue, red. Streak red. Powder dark red. Lustre metallic. Hardness 9 to 10. Not brittle. Sp. gr. 5.0116 † to 5.218 ‡. Slightly magnetic. Little altered by the blow-pipe. Tinges borax an obscure yellow.

This ore, according to Mr Musket, is composed of

66.1 iron,
21.2 oxygen,
10.7 water and carbonic acid,
2.0 lime.

100.0 †

The quantity of oxygen here stated is probably too small, owing to the unavoidable inaccuracy which results from the *dry way* of analysis which Mr Musket followed.

Micaceous iron ore

Is generally considered as a variety of this species. Kirwan, however, supposes it to contain carbon, and to be a distinct species.

It is found in Saxony, and in the isle of Elba, &c. generally in amorphous masses, composed of thin six-sided laminae. Colour iron grey. Streak bluish grey. Lustre metallic. Opaque. Feels greasy. Hardness 5 to 7. Brittle. Sp. gr. from 4.5 to 5.07. Slightly magnetic.

Metallic Ores.

* Kirwan,
ii.—Dupuget, Jour. de Min. N^o xxi. p. 75.
† Fourcroy, Ann. de Chim. ii. 127.
‡ Min. ii. 161.

221
Specular iron ore.
† Kirw. ii. 162.—Coudrai, Jour. de Phys. iv. 52.
* Haüy, Jour. de Min. N^o xxxiii. 660.
‡ Fig. 39.
† Crysl. iii. 189.
‡ Ibid. 660.
† Haüy, Briffon.

† Philof. Mag. iii. 354.

Iron Ores. magnetic. Infusible by the blow-pipe. Tinges borax greenish brown.

222
Laminated specular iron ore.

SPECIES 3. Laminated specular iron ore.
Fer pyroceli of Haüy.

This ore, which is found at Montd'or in Auvergn, was usually arranged under the last species; but has been separated from it, we think properly, by Mr Haüy, because the form of its crystals is incompatible with the supposition that their primitive nucleus is a cube, as we have seen is the case with common specular iron ore. Its crystals are thin octagonal plates, bounded by six linear trapeziums, alternately inclined different ways*.

* De Lisle, iii. 188.

Colour steel grey. Powder reddish black. Lustre metallic; surface polished. Fracture glassy. Very brittle†. Haüy supposes that this ore has been produced by fire, and accordingly has given it a name which denotes its origin.

† Haüy, Jour. de Min. N° xxxi. 33.

223
Brown iron ore.

SPECIES 4. Brown iron ore‡.

‡ Kirw. ii. 163.

This species of ore is found abundantly in Britain, particularly in Cumberland and Lancashire; and it is also very common in other counties. It consists of the brown oxide of iron, more or less contaminated with other ingredients.

Its colour is brown. Its streak reddish brown. Sp. gr. from 3.4771 to 3.951. Before the blow-pipe blackens, but does not melt. Tinges borax greenish yellow.

Variety 1. Brown hæmatites.

The name hæmatites (bloodstone) was probably applied by the ancients only to those ores which are of a red colour, and have some resemblance to clotted blood; but by the moderns it is applied to all the ores of iron which give a reddish coloured powder, provided they be of a fibrous texture.

Brown hæmatites occurs in masses of various shapes, and it is said also to have been found crystallized in five or six sided acute angled pyramids. Colour of the surface brown or black, sometimes iridescent; internally nut brown. Powder red. Texture fibrous. Hardness 8 to 10. Brittle. Sp. gr. 3.789§ to 3.951||. Not magnetic.

§ Gellert. || Kirwan.

This variety has not been analysed, but it seems to consist of brown oxide of iron, oxide of manganese, and

¶ Kirwan's alumina ¶.
Min. ii. 164.

Variety 2. Compact brown iron stone.

This variety occurs in masses of very various and often fantastical shapes.

Colour brown. Internal lustre metallic. Texture compact. Hardness 6 to 9. Brittle. Sp. gr. 3.4771* to 3.551†.

* Briffon. † Kirwan.

Variety 3. Brown scaly iron ore.

This variety is generally incumbent on other minerals. Colour brown. Lustre metallic. Stains the fingers, marks strongly. Feels unctuous. Texture foliated. Hardness 3 to 5. Brittle. So light as often to float on water.

Variety 4. Brown iron ochre.

This variety occurs both massive and disseminated. Colour from nut brown to orange. Lustre o. Strongly stains the fingers. Texture earthy. Hardness 3 to 4. When slightly heated reddens.

224
Red iron ore.
† Kirw. ii. 168.

SPECIES 5. Red iron ore‡.

Colour red. Streak blood red. Sp. gr. from 3.423

to 5.005. Before the blow-pipe blackens, but does not melt. Tinges borax yellowish olive green. When digested in ammonia, it becomes black and often magnetic.

Metallic Ores.

Variety 1. Red hæmatites.

Found in masses, and all the variety of forms of stalactites. Colour between brownish red and steel grey. Powder red. Internal lustre metallic. Texture fibrous. Hardness 9 to 10. Brittle. Sp. gr. 4.74* to 5.005†. * Gellert.

When pure it consists of red oxide of iron, but it often contains manganese and alumina‡.

† Kirwan's Min. ii. 169.

Variety 2. Compact red iron ore.

Found massive and stalactitic; sometimes in crystals of various forms, but they seem to be only secondary; sometimes in columns like basalt.

Colour between brown red and steel grey. Stains the fingers. Lustre 1 to 0; often semimetallic. Texture compact. Hardness 7 to 9. Brittle. Sp. gr. 3.423 to 3.76§. Sometimes invested with a rosy red§ Kirwan's ochre.

Variety 3. Red ochre.

Found sometimes in powder, sometimes indurated. Colour blood red. Stains the fingers. Lustre o. Texture earthy. Hardness 3 to 5. Brittle.

Variety 4. Red scaly iron ore.

This variety is generally found incumbent upon other iron ores. Colour between cherry red and steel grey. Stains the fingers. Lustre silky, inclining to metallic. Texture foliated. Feels unctuous. Hardness 3 to 4. Brittle. Heavy.

SPECIES 6. Argillaceous iron ore ||.

225
Argillaceous iron

Oxid of iron combined or mixed with clay.

This ore is exceedingly common; and though it contains less iron than the species already described, it is, in this country at least, preferred to them, because the method of extracting pure iron from it is easier, or rather because it is better understood.

Colour most commonly dark brown. Streak red or yellowish brown. Sp. gr. from 2.673 to 3.471*. Before the blow-pipe blackens, and tinges borax olive green and blackish. It is composed of oxide of iron, alumina, lime, silica in various proportions. It generally yields from 30 to 40 per cent. of iron.

* Kirwan.

Variety 1. Common argillaceous iron ore.

The minerals arranged under this variety differ considerably from each other in their external characters. They are found in masses of various shapes, and often form large strata.

Colour various shades of grey, brown, yellow, and red. Streak reddish yellow or dark red. Lustre o. Hardness from 3 to 8. Smell earthy when breathed upon.

Variety 2. Columnar or scapiform iron ore.

This variety is found in columns, adhering to each other, but easily separable: They are commonly incurvated, and their surface is rough. Colour brownish red. Streak dark red. Slightly stains the fingers. Lustre o. Adheres strongly to the tongue. Sound hollow. Feel dry. Texture earthy.

Variety 3. Acinose iron ore.

This variety is found in masses, and is commonly lenticular. Colour generally brownish red. Lustre metallic, nearly. Texture granular. Hardness 5 to 9. Brittle.

Variety

Iron Ores.

Variety 4. Nodular, or kidney-form iron ore.

Ætites or Eaglestone.

This variety, which was mentioned by the ancients, is generally found under the form of a rounded knob, more or less resembling a kidney, though sometimes it is quadrangular; and it contains within it a kernel, which is sometimes loose, and sometimes adheres to the outside rind. Colour of the stone yellowish brown; of the kernel ochre yellow. Surface generally fouled with earth. Lustre of the rind metallic; of the kernel o. Hardness from 4 to 7. Brittle.

Variety 5. Pisiform or granular iron ore.

This variety occurs in rounded masses, from the size of a pea to that of a nut. Surface rough. Colour commonly dark brown. Streak yellowish brown. Hardness 5 to 6. Brittle.

The oolitic ore found at Creusot, near mount Ceniz, belongs to this variety. It is composed of

50 lime,
30 iron,
20 alumina.

100

SPECIES 7. Lowland iron ore *.

226
Lowland
iron ore.
* Kirw. II.
279.

This species of ore is supposed to consist of oxide of iron, mixed with clay and phosphuret or phosphat of iron. It is called lowland ore, because it is found only in low grounds; whereas the last species is more commonly in high grounds; and is therefore called *highland ore*.

This ore occurs in amorphous masses, and also in grains or powder. Its colour is brown. Streak yellowish brown. Lustre o, or common. Texture earthy. Hardness 3 to 5.

Variety 1. Meadow lowland ore.

Colour blackish or yellowish brown: Both colours often meet in the same specimen. Found in lumps of various sizes, often perforated. Fracture compact. Moderately heavy.

Frequently yields from 32 to 38 per cent. of iron.

Variety 2. Swampy iron ore.

This variety is generally found under water. It is in lumps, which are commonly perforated or corroded, and mixed with sand. Colour dark yellowish brown, or dark nut brown. Hardness 3 to 4. Brittle. Sp. gr. 2.944. It often contains .36 of iron.

Variety 3. Morassy iron ore.

This variety is found either in a loose form or in perforated lumps. Colour light yellowish brown. Stains the fingers. Hardness 3. Friable.

GENUS VI. SALTS OF IRON.

SPECIES 1. Sparry iron ore (G).

This ore is common in Germany, France, and Spain.

227
G. VI. Salts.
Sparry iron
ore.

It is found sometimes in amorphous masses, and sometimes crystallized.

Its colour is white; but it becomes tarnished by exposure to the air, and then assumes various colours. Streak grey or white. External lustre often metallic; internal common or glassy. Transparency 1 or 2; sometimes o. Texture foliated. Fragments rhomboidal. Hardness 5 to 7. Brittle. Sp. gr. 3.6 to 3.810. Not magnetic. Soluble in acids with very little effervescence. Before the blow-pipe decrepitates, becomes brownish black, and magnetic; but is scarcely fusible. Tinges borax smutty yellow, with some effervescence.

This ore, as Bergman ascertained, consists of iron, manganese, lime, and carbonic acid.

One specimen, according to his analysis, contained

38 iron,
24 manganese,
38 carbonat of lime.

100

Another contained 22 iron,
28 manganese,
50 carbonat of lime.

100

Whether the iron be combined with the carbonic acid is still a disputed point. The crystals of this ore are rhomboidal parallelepipeds; which is precisely the form of carbonat of lime. This amounts nearly to a demonstration, that the carbonic acid is combined with the lime; and that, as Cronstedt and Haüy have supposed, this ore is merely carbonat of lime, contaminated with a quantity of the oxides of iron and manganese.

SPECIES 2. Arseniat of iron.

228
Arseniat of
iron.

Mr Proust has discovered this ore in Spain. Its colour is greenish white. Its texture granular. Insoluble in water and nitric acid. When melted on charcoal, the arsenical acid escapes with effervescence *.

SPECIES 3. Sulphat of iron.

For a description of this salt, see CHEMISTRY, n° 631. in this *Suppl.*

* Ann. de
Chim. i. 195.
229
Sulphat of
iron.

ORDER VII. TIN ORES (H).

Tin is employed to cover plates of iron and copper, and to silver the backs of looking glasses: It enters into the composition of pewter; and forms a very important article in dyeing.

Tin ores are by no means so common as the ores of the metals which we have already described. They are found only in the *primitive mountains* (1). Hence Werner supposes them to be the most ancient of all metallic ores. They occur most frequently in granite, sometimes in porphyry, but never in limestone.

230
Mines.

Almost

(c) Kirw. II. 190.—Bergman, II. 184.—Bayen, *Jour. de Phys.* VII. 213.—Razowmowski, *Mem. Lausanne*, 1783, p. 149.

(H) Geoffroy, *Mem. Par.* 1738, p. 103.—Morveau, *Ann. de Chim.* XXIV. 127.

(1) Geologists have divided mountains into three classes; *primitive*, *secondary*, and *tertiary*. The *primitive* occupy the centre of all extensive chains; they are the highest, the most rugged, and exhibit the most pointed tops. They are considered as the most ancient mountains of the globe.

The *secondary* mountains occupy the outside of extensive ranges. They are usually composed of strata, more or less inclined, and commonly rest against the sides of the *primitive* mountains.—The *tertiary* mountains are much smaller than the others, and are often solitary. We use the terms *primitive*, *secondary*, &c. merely as proper

Tin Ores.

Almost the only tin mines known to Europeans are those of Cornwall, Devonshire, Saxony, Bohemia, Silesia, Hungary, Galicia; those of the island of Banca and the peninsula of Malacca in India; and those of Chili and Mexico and America.

tinstone, we refer the reader to *Romé de Lisle* and *Mr Day* *.

Its colour is commonly brown. Streak grey. Hardness 9 to 10. Sp. gr. 6.9 to 7.0. Brittle.

Variety 1. Common tinstone.

Colour dark brown; sometimes yellowish grey, and sometimes nearly white. Streak light grey. Somewhat transparent when crystallized. Hardness 10. Sp. gr. 6.9 to 6.97. Before the blow-pipe it decrepitates, and on charcoal is partly reduced. Tinges borax white.

According to Klaproth, it is composed of

77.50 tin,
21.50 oxygen,
.25 iron,
.75 silica.

100.00 †

Variety 2. Woodtin.

This variety has hitherto been found only in Cornwall. It occurs always in fragments, which are generally rounded. Colour brown; sometimes inclining to yellow. Streak yellowish grey. Opaque. Texture fibrous. Hardness 9. Sp. gr. 7.0. Before the blow-pipe becomes brownish red; decrepitates when red hot, but is not reduced.

Klaproth obtained from it .63 of tin; and, in all probability, it is an oxide of tin nearly pure.

ORDER VIII. ORES OF LEAD.

The useful purposes to which lead in its metallic state is applied, are too well known to require description. Its oxides are employed in painting, in dyeing, and sometimes also in medicine.

Ores of lead occur in great abundance in almost every part of the world. They are generally in veins; sometimes in siliceous rocks, sometimes in calcareous rocks.

GENUS I. SULPHURETS OF LEAD.

SPECIES 1. Galena, or pure sulphuret of lead †.

This ore, which is very common, is found both in masses and crystallized. The primitive form of its crystals is a cube. The most common varieties are the cube, sometimes with its angles wanting, and the octohedron, composed of two four-sided pyramids applied base to base: The summits of these pyramids are sometimes uneven, and sometimes their solid angles are wanting †.

Its colour is commonly bluish grey, like lead. Streak bluish grey and metallic. Lustre metallic. Sometimes stains

231
G. I. Sulphurets.
Sulphuret of tin and copper
* *Kirw.* ii. 200.

† *Klaproth* &
Cornwall,
p. 21.
† *Klaproth*.

GENUS I. SULPHURETS OF TIN.
SPECIES 1. Sulphuret of tin and copper *.

Tin pyrites.

Hitherto this ore has only been found in Cornwall. There is a vein of it in that county, in the parish of St Agnes, nine feet wide, and twenty yards beneath the surface †.

Its colour is yellowish grey, passing into the steel grey. Not unlike grey copper ore. Lustre metallic. Hardness 5 to 6. Very brittle. Sp. gr. 4.35 †. Before the blow-pipe it melts easily, with a sulphureous smell, into a black bead, and deposits a bluish oxide on the charcoal.

The composition of this ore, as Klaproth informs us, was first discovered by Mr Raspe. According to Klaproth's analysis, it is composed of

34 tin,
36 copper,
25 sulphur,
3 iron,
2 earth.

100 †.

§ *Id.* 58.

232
G. II. Oxides. Brown oxide of tin
* *Kirw.* ii. 197.

GENUS II. OXIDES OF TIN.
SPECIES 1. Brown oxide of tin *.

Tinstone—Woodtin.

This ore, which may be considered as almost the only ore of tin, occurs in masses, in rounded pieces, and crystallized. These crystals are very irregular. Haüy supposes, that their primitive form is a cube †; but *Romé de Lisle*, with more probability, makes it an octohedron †; and in this opinion Mr Day agrees with him †. The octohedron is composed of two four-sided pyramids, applied base to base. The sides of the pyramids are isosceles triangles, the angle at the vertex of which is 70°, and each of the other angles 55°. The sides of the two pyramids are inclined to each other at an angle of 90° †. The primitive form, however, never occurs, but crystals of tinstone are sometimes found, in which the two pyramids are separated by a prism. For a complete description of the varieties of the crystals of

† *Four. de Min.* No xxxii. 576.
† *Cryсталlog.* iii. 413.
|| *Philos. Mag.* iv. 152.

§ *Romé de Lisle*, *ibid.*

233
G. I. Sulphurets.
Galena, or pure sulphuret of lead.
† *Kirw.* ii. 216.

|| *Romé de Lisle*, iii. 364.

proper names, without affirming or denying the truth or falsehood of the theory on which these names are founded. That the reader may have a more accurate idea of the composition of these different classes of mountains, we have subjoined a list of the substances which, according to Werner, enter into the composition of each.

I. PRIMARY MOUNTAINS.

- | | | | |
|------------------------|---------------------------|-------------------------|-----------------|
| 1. Granite, | 4. Argillaceous schistus, | 7. Siftose porphyry, | 10. Serpentine, |
| 2. Gneiss, | 5. Syenite, | 8. Quartz, | 11. Topaz rock. |
| 3. Micaceous schistus, | 6. Porphyry, | 9. Primitive limestone, | |

II. SECONDARY MOUNTAINS.

- | | | |
|---------------------------|-------------------------|----------------|
| 1. Argillaceous schistus, | 3. Secondary limestone, | 5. Gneiss, |
| 2. Rubble stone, | 4. Siftose hornblende, | 6. Amygdaloid. |

III. TERTIARY MOUNTAINS.

- | | | | |
|---------------------------|---------------|---------------------|-----------------------|
| 1. Trap, | 4. Sandstone, | 7. Chalk, | 10. Ferruginous clay, |
| 2. Argillaceous schistus, | 5. Breccia, | 8. Sulphat of lime, | 11. Potters earth, |
| 3. Stratified limestone, | 6. Coal, | 9. Rock salt, | |

Ores of Lead.

§ Walsen.

stains the fingers. Texture foliated. Fragments cubical. Hardness 5 to 7; sometimes even 9. Brittle. Sp. gr. 6.884 to 7.786 §. Effervesces with nitric and muriatic acids. Before the blow-pipe decrepitates, and melts with a sulphureous smell; part sinks into the charcoal.

It is composed of from .45 to .83 lead, and from .086 to .16 of sulphur. It generally contains some silver, and sometimes also antimony and zinc.

Variety 1. Common galena.

This variety corresponds nearly with the above description. Sp. gr. 7.051 to 7.786. Sometimes stains the fingers.

Compact galena.

Found only in amorphous masses. Texture compact, inclining to foliated. Hardness 6 to 8. Sp. gr. 6.886 to 7.444. Lustre common. Streak lead grey, brighter and metallic. Often feels greasy, and stains the fingers.

234
Sulphuret of lead, with silver and antimony.
* Kirw. ii.
219.

SPECIES 2. Sulphuret of lead, with silver and antimony*. *Plumbiferous antimoniated silver ore.*

Found in amorphous masses. Colour grey. Hardness 5 to 6. Brittle. Sp. gr. from 5.2 to 8.

Variety 1. Light grey silver ore.

Colour light bluish grey. Streak light bluish grey, and brighter. Lustre metallic. Texture compact. Before the blow-pipe partly evaporates, and leaves a silver bead on the charcoal, surrounded by yellow dust.

According to Klaproth, it contains

48.06 lead,
20.40 silver,
7.88 antimony,
12.35 sulphur,
2.25 iron,
7.00 alumina,
.25 silica.

98.09 †

Variety 2. Dark grey silver ore.

Colour iron grey, verging on black. Powder black, and stains the fingers. Lustre o, Texture earthy.

According to Klaproth, it contains

41.00 lead,
21.50 antimony,
29.25 silver,
22.00 sulphur,
1.75 iron,
1.00 alumina,
.75 silica.

97.25 †

SPECIES 3. Blue lead ore*.

This ore, which is found in Siberia, Germany, and Hungary, and is very rare, occurs sometimes in masses, and sometimes crystallized in six-sided prisms.

Colour between indigo blue and lead grey; sometimes inclining to black. Internal lustre metallic. Streak brighter. Texture compact. Hardness 6. Sp. gr. 5.461 †. Before the blow-pipe melts with a low blue flame and a sulphureous smell, and is easily reduced.

SPECIES 4. Black lead ore †.

This ore, which is found in Germany and Brittany,

SUPPL. VOL. II. Part I.

and which is supposed to be common galena decayed, is sometimes in stalactites of various forms, and sometimes crystallized in six-sided prisms, which are generally truncated and confused.

Colour black, often with some streaks of red. Streak light bluish grey. Internal lustre metallic. Hardness 5 to 6. Brittle. Sp. gr. from 5.744 † to 5.77*. Before the blow-pipe decrepitates, melts easily, and is reduced.

According to the experiments of Laumont, this ore is a sulphuret of lead (or rather sulphuret of oxide of lead), mixed with some phosphat of lead.

SPECIES 5. Sulphuret of lead, bismuth, and silver.

This ore, which occurs in the valley of Schapbach in Saxony, was first taken notice of by Selb, and afterwards described by Weidenmann and Emerling.

Its colour is light bluish grey. Its lustre metallic. Its fracture uneven. Hardness 5. Melts easily before the blow-pipe, emitting some smoke, and leaves a silver bead.

A specimen, analysed by Mr Klaproth, contained

33.0 lead,
27.0 bismuth,
15.0 silver,
16.3 sulphur,
4.3 iron,
0.9 copper.

96.5 †

GENUS II. OXIDES OF LEAD.

SPECIES 1. Lead ochre †.

This ore, which is a mixture of the oxide of lead with various earths, is found massive, and various degrees of hardness.

Its colour is either yellow, grey, or red. Lustre o. Transparency o to 1. Hardness 6 to 8; sometimes in powder. Sp. gr. from 4.165 to 5.545 §. Texture compact. Effervesces with nitric and muriatic acids. Easily reduced by the blow-pipe, leaving a black slag, unless the lead be mixed with too great a proportion of earth.

GENUS III. SALTS OF LEAD.

SPECIES 1. Carbonat of lead †.

White lead spar.

This ore of lead, which is very common, is sometimes in masses, and sometimes crystallized. But the crystallization is in general so confused, that the primitive form of the crystals has not yet been ascertained (κ).

Its colour is white. External lustre, waxy or silky, from 3 to 1; internal 1 to 2. Generally somewhat transparent. Hardness 5 to 6. Brittle. Sp. gr. from 5.349 † to 6.92 §. Effervesces with nitric and muriatic acids when they are heated. Soluble in fat oils. Blackened by sulphuret of ammonia*. Decrepitates when heated. Before the blow-pipe, in a silver spoon, it becomes red by the yellow cone of the flame, while the blue cone renders it yellow †. On charcoal it is immediately reduced.

It contains from .60 to .85 of lead, and from .18 to .24 of carbonic acid. It is generally contaminated with carbonat of lime and oxide of iron.

H h

SPECIES

Metallic Ores.

Briffon.
Gellert.

237
Sulphuret of lead, bismuth, and silver.

† Beiträge, ii. 297.

238
G. II. Oxides. Lead ochre.
† Kirw. ii. 205.

† Kirwan.

239
G. III. Salts. Carbonat of lead.
† Kirw. ii. 103.

† Kirwan.
§ Gellert.
* Pelletier, Ann. de Chim. ix.

† Ribben-tropp, Ann. de Chim. de Chim. 189.

Ores of
Lead.240
Phosphat
of lead.
* Kirw. ii.
207.

SPECIES 2. Phosphat of lead *.

This ore, which is found in Siberia, Scotland, England, Germany, Carinthia, Brittany, &c. is sometimes amorphous, and sometimes crystallized. The primitive form of its crystals, according to Romé de Lisle, is a dodecahedron, consisting of a six-sided rectangular prism, terminated by six-sided pyramids, the sides of which are isosceles triangles (L). Sometimes the pyramids are truncated, and even altogether wanting. The crystals of this ore are often acicular.

Its colour is commonly green; sometimes yellowish or brownish, or greyish white. Streak commonly greenish white. Powder yellowish. External lustre, waxy, 2 to 3. Somewhat transparent, except when its colour is greyish white. Hardness 5 to 6. Brittle. Sp. gr. from 5.86* to 6.27†. Insoluble in water and sulphuric acid, and nearly insoluble in nitric acid; soluble in hot muriatic acid, with a slight effervescence †. Before the blow-pipe it easily melts on charcoal, and crystallizes on cooling: with soda the lead is in some measure reduced.

The composition of this ore was first discovered by Gahn.

According to Fourcroy's analysis, a specimen from Erlenbach in Alsace consists of

96 phosphat of lead,
2 phosphat of iron,
2 water.

100

Or it contains 79 oxide of lead,
1 oxide of iron,
18 phosphoric acid,
2 water.

¶ Ibid.

100 ¶

241
Arseniat
of lead.
§ Kirw. ii.
209.

SPECIES 3. Arseniat of lead §.

This ore, which has hitherto been found only in Andalusia in Spain, and always in quartz or feldspar, is in small masses. Colour meadow green, often passing into wax yellow. Lustre waxy, 2. Transparency 2. Before the blow-pipe it melts, and retains its colour, and does not crystallize on cooling. When heated to whiteness, the arsenic acid escapes, and the lead is reduced*.

* Proust,
Jour. de
Phys., xxx.
394.

SPECIES 4. Phosphat and arseniat of lead.

Arseniat phosphat of lead †.

242
Phosphat
and arseniat
of lead.
† Kirw. ii.
210.

This ore, which has been found in Auvergne in France, is either in masses, or crystallized in small fixed prisms, with curvilinear faces.

Colour yellowish green, or shews alternate layers of pale and light green. Powder yellowish. The crystals are somewhat transparent; but when massive, this ore is opaque. Hardness 5 to 7. Brittle. Sp. gr. 6.8465 †. Soluble in hot muriatic acid, but not in nitric. When heated it decrepitates. Before the blow-pipe melts easily, effervesces, emits a white smoke, with an arsenical smell. Some particles of lead are reduced, a brown fluid remains, which crystallizes on cooling like phosphat of lead.

† Briffon.

According to Fourcroy, from whom the whole of this description has been taken, it is composed of

65 arseniat of lead,
27 phosphat of lead,
5 phosphat of iron,
3 water.

100*

* Ann. de
Chim. ii. 23.

SPECIES 5. Molybdat of lead (M).

This ore, which is found in Carinthia and at Lead-hills in Scotland, was first mentioned in 1781 by Mr Jacquin (N). It occurs either in masses, or crystallized in cubic, or rhomboidal, or octohedral plates.

Its colour is yellow. Streak white. Lustre waxy. Generally somewhat transparent. Texture foliated. Fracture conchoidal. Hardness 5 to 6. Sp. gr. 5.486†; when purified from its gangue by nitric acid, 5.706 †.

Soluble in fixed alkalies and in nitric acid. Communicates a blue colour to hot sulphuric acid. Soluble in muriatic acid, and decomposed by it. Before the blow-pipe decrepitates, melts into a yellowish grey mass, and globules of lead are reduced †.

Klaproth first proved that this ore was molybdat of lead.

A very pure specimen, analysed by him, contained

64.42 oxide of lead,
34.25 molybdic acid,

98.67 ¶

¶ Beitr. äge,
ii. 275.

According to the analysis of Mr Hatchett, it is composed of

58.40 oxide of lead,
38.00 molybdic acid,
2.10 oxide of iron,
.28 silica.

98.78*

Macquart found a specimen to contain

58.74 lead,
4.76 oxygen,
28.00 molybdic acid,
4.50 carbonat of lime,
4.00 silica.

* Phil.
Transf.
lxxxvi. 323.

100.00†

Its gangue is carbonat of lime.

SPECIES 6. Sulphat of lead *.

This ore, which is found in Anglesey and in Andalusia, is generally crystallized. The crystals are regular octahedrons †, and very minute.

Colour white. Lustre 4. Transparency 4. Before the blow-pipe it is immediately reduced.

The composition of this ore was first ascertained by Dr Withering.

244
Sulphat of
lead.* Kirw.
Min. ii.
211.
† Haüy,
Jour. de
Min. N°
xxx. 508.

ORDER IX. ORES OF ZINC.

HITHERTO zinc has not been applied to a great variety of uses. It enters into the composition of brass; it is used in medicine; and Morveau has shewn that its oxide

(L) *Crystal.* III. 391. See also Haüy's remarks on the same subject in the *Jour. de Min.* N° XXXI. 506.

(M) *Kirw.* II. 212.—*Klaproth, Ann. de Chim.* VIII. 103.—*Hatchett, Phil. Transf.* 1796, p. 285.

(N) In his *Miscellanea Austriaca*, Vol. II. p. 139.

Order IX.

MINERALOGY.

243

Ores of Zinc.

oxide might be employed with advantage as a white paint.

Ores of zinc are very abundant; they generally accompany lead ores, particularly galena. Calamine, or oxide of zinc, has never been discovered in the primitive mountains.

245
G. I. Sulphurets.
Common sulphuret of zinc.

GENUS I. SULPHURETS OF ZINC.
SPECIES I. Common sulphuret of zinc *.
Blende.

This ore very commonly accompanies sulphuret of lead. It occurs both in amorphous masses and crystallized. The primitive form of its crystals is a rhomboidal dodecahedron, consisting of a six-sided prism, terminated by three-sided pyramids. All the faces of the crystals are equal rhombs. This dodecahedron may be mechanically divided into four equal rhomboidal parallelepipeds, and each of these into six tetrahedrons, whose faces are equal isosceles triangles. The figure of its integrant particles is the tetrahedron, similar to these†.

† Haüy, *Jour. de Min.* No xxxii. 669. ‡ Fig. 40. § Fig. 41. || See Haüy, *ibid.* and *Romé de Lisle*, iii. 65. * Gillert. † Briffon.

The principal varieties of its crystals are the tetrahedron; the octohedron; the octohedron with its edges wanting†; a 24-sided crystal, 12 of whose faces are trapezoids, and 12 elongated triangles§; and, lastly, a 28-sided figure, which is the last variety, augmented by four equilateral triangles||.

Colour yellow, brown, or black. Streak reddish, brownish, or grey. Lustre commonly metallic. Generally somewhat transparent. Texture foliated. Hardness 6 to 8. Sp. gr. 3.93* to 4.1665†. Before the blow-pipe decrepitates, and gives out white flowers of zinc, but does not melt. Borax does not affect it. When breathed upon, loses its lustre, and recovers it very slowly‡.

Variety 1. Yellow blende.

Colour commonly sulphur yellow, often passing into olive green or brownish red. Powder pale yellow. Streak yellowish or reddish grey, not metallic. Lustre metallic. Transparency 2 to 4. Often phosphoresces when scraped or rubbed§.

According to Bergman, it is composed of

64 zinc,
20 sulphur,
5 iron,
4 fluor acid,
1 silica,
6 water.

100 ||

Variety 2. Brown blende.

Colour different shades of brown. Surface often tarnished. Powder brownish grey. Streak reddish or yellowish grey, not metallic. Lustre commonly metallic. Transparency 0 to 2.

A specimen of this variety, analysed by Bergman, contained

44 zinc,
17 sulphur,
24 silica,
5 iron,
5 alumina,
5 water.

100 ¶

Variety 3. Black blende.

Colour black, or brownish black; surface often tar-

nished blue; tips of the crystals often blood red. Powder brownish black. Streak reddish, brownish, or grey. Lustre common or metallic. Transparency 0 to 1; the red parts 2. Hardness 8.

A specimen of this variety, analysed by Bergman, contained

52 zinc,
26 sulphur,
4 copper,
8 iron,
6 silica,
4 water.

100 *

GENUS II. OXIDES OF ZINC.
SPECIES I. White oxide of zinc †.
Calamine.

This ore is either found loose, or in masses, or crystallized. The primitive form of its crystals appears, from the mechanical division of one of them by Mr Haüy, to be an octohedron composed of two four-sided pyramids, whose sides are equilateral triangles†. But the crystals are minute, and their figure not very distinct. They are either four or six-sided tables with bevelled edges, six-sided prisms, or three-sided pyramids.

Colour commonly white, grey, or yellow. Lustre often 0, sometimes 2 or 1. Opaque. The crystals are somewhat transparent. Hardness from 4 to 9, sometimes in powder. Sp. gr. from 2.585 to 3.674§. When heated, becomes electric, without friction, like the tourmaline||. Not blackened by sulphuret of ammonia. Soluble in sulphuric acid. Before the blow-pipe decrepitates, and does not melt.

This ore consists of oxide of zinc more or less contaminated with iron, silica, lime, and other foreign ingredients. In one specimen Bergman found the following ingredients:

84 oxide of zinc,
3 oxide of iron,
12 silica,
1 alumina.

100 ¶

In another specimen, which gelatinized with acids like zeolite, Klaproth found 66 oxide of zinc,

33 silica,

99

In another specimen, analyzed by Pelletier, the contents were

52 silica,
36 oxide of zinc,
12 water.

100 *

Mr Kirwan has divided this species into three varieties.

Variety 1. Friable calamine.

In masses which easily crumble between the fingers. Lustre 0. Opaque. Texture earthy. When its colour is white, it is pure oxide of zinc; when yellow, it is mixed with oxide of iron. The white often becomes yellow when placed in a red heat, but resumes its colour on cooling. Common in China, where it is called *wohan* or ore of *Tutenago*.

H h 2

Variety.

Metallic Ores.

* Bergman, ii. 335.

246

G. II.

Oxides.

White oxide of zinc.

† Kirwan, ii.

233.—Berg.

ii. 321.

† Haüy, *Jour. de Min.* No xxxii. 596.

§ Kirwan.

|| Haüy, *Jour. de Min.* *ibid.*

¶ Bergman, ii. 323.

* Jour. de Phys. xx. 428.

Ores of
Antimony.

Variety 2. Compact calamine.
Colour different shades of grey; sometimes yellow or brownish red. Lustre o. Opaque. Texture compact.

Variety 3. Striated calamine.

This variety alone is found crystallized; but, like the others, it is also often amorphous. Colour white, and also various shades of grey, yellow, and red. Somewhat transparent. Texture striated. Lustre 2 to 1.

247
G. III.
Salts.
Sulphat of
zinc.

GENUS III. SALTS OF ZINC.

SPECIES 1. Sulphat of zinc.

For a description of this salt, we refer to CHEMISTRY, n° 643. *Suppl.*

ORDER X. ORES OF ANTIMONY.

Antimony is much used to give hardness to those metals which otherwise would be too soft for certain purposes; printers types, for instance, are composed of lead and antimony. It is used also in medicine.

Ores of antimony are found abundantly in Germany, Hungary, France, Spain, Britain, Sweden, Norway, &c. They often accompany galena and hæmatites. They are found both in the secondary and primitive stratified mountains. Their gangue (o) is often quartz and sulphat of barytes.

248
G. I. Alloys
Native an-
timony.
* Kirw. ii.
245.

GENUS I. ALLOYS OF ANTIMONY.

SPECIES 1. Native antimony*.

This mineral, which was first discovered by Dr Swab, has been found in Sweden and in France, both in masses and kidney shaped lumps. Colour white, between that of tin and silver. Lustre metallic. Texture foliated. Hardness 6. Sp. gr. above 6. Deflagrates with nitre. Before the blow-pipe melts and evaporates, depositing a white oxide of antimony.

It consists of antimony, alloyed with 3 or 4 per cent. of arsenic.

GENUS II. SULPHURETS OF ANTIMONY.

SPECIES 1. Grey ore of antimony*.

This ore, which is the most common, and indeed almost the only ore of antimony, occurs both massive, disseminated, and crystallized. Its crystals are four-sided prisms, somewhat flattened, whose sides are nearly rectangles, terminated by short four-sided pyramids, whose sides are trapeziums †. Sometimes two of the edges are wanting, which renders the prism six-sided ‡.

Colour grey. Lustre metallic. Streak grey, metallic, and brighter. Powder black or greyish black. Hardness 6 to 7. Sp. gr. from 4.327 to 4.516 §. Often stains the fingers. Before the blow-pipe melts easily, burns with a blue flame, and deposits a white oxide on the charcoal. When placed in an open vessel, over a slow fire, the sulphur evaporates, and leaves a grey oxide of antimony. This oxide, if fused with tartar, is reduced.

This ore, when taken out of the mine, almost always

contains a large proportion of quartz or other stony matter. When pure, it is composed of about
74 antimony,
26 sulphur.

100

Werner has divided this species into three varieties.

Variety 1. Compact sulphuret.

Colour bluish grey, surface often tarnished, and then it is blue or purplish. Lustre 1 to 2. Texture compact. Fracture fine grained, uneven. Powder black, dull, and earthy. Slightly stains the fingers.

Variety 2. Foliated sulphuret.

Colour light steel grey. Lustre 3 to 4. Texture foliated. Powder as that of the last variety.

Variety 3. Striated sulphuret.

Colour dark steel grey, and light bluish grey, surface often tarnished, and then it is dark blue or purplish. Lustre 3 to 2. Texture striated. Powder greyish black. This variety alone has been hitherto found crystallized.

SPECIES 2. Plumose antimonial ore †.

Sulphurets of antimony and arsenic.

This species, which is sometimes found mixed with the crystals of sulphurated antimony, is in the form of brittle, capillary, or lanuginous crystals, often so small that they cannot be distinctly seen without a microscope.

Colour steel or bluish grey, often tarnished, and then brown or greyish black. Lustre 1, semimetallic. Before the blow-pipe emits a smoke, which deposits a whitish and yellowish powder on the charcoal: it then melts into a black slag.

It is supposed to consist of sulphur, antimony, arsenic, and some silver.

SPECIES 3. Red antimonial ore †.

Hydrosulphuret of antimony.

This species is generally found in cavities of sulphurated antimonial ore. It is crystallized in delicate needles, often diverging from a common centre.

Colour red. Lustre 2, silky. Sp. gr. 4.7. Before the blow-pipe melts easily, and evaporates with a sulphureous smell.

This ore has not been analysed. Mineralogists have supposed it to be a natural kermes. If so, we may conclude, from the experiments of Berthollet*, that it is a hydrosulphuret of antimony, and consequently composed of oxide of antimony, sulphur, and sulphurated hydrogen gas.

GENUS III. OXIDES OF ANTIMONY.

There is a substance found incumbent on sulphuret of antimony, of a yellow colour, and an earthy appearance, which has been supposed an oxide of antimony, and denominated antimonial ochre. But hitherto it has not been analysed.

GENUS

(o) The word *gang* is used by German mineralogists to denote a metallic vein. Now, it is not often that these veins consist entirely of ore; in general, they contain stony matter besides. For instance, in the copper mine at Airthry, near Stirling, the copper ore is merely a narrow stripe in the middle of the vein, and the rest of it is filled up with sulphat of barytes. We use the word *gangue* (as the French do), to denote, not the metallic vein, but the stony matter which accompanies the ore in the vein. The gangue of the copper ore at Airthry is sulphat of barytes.

249
G. II. Sul-
phurets.
Grey ore
of anti-
mony.
* Kirw. ii.
247.
† Romé de
Lisse, iii.
49.
‡ Ibid.—See
also Haüy,
Jour. de
Min. N°
xxxiii. 606.
§ Briffon.

250
Plumose
antimonial
ore.
† Kirw. ii.
250.

251
Red anti-
monial ore.
† Kirw. ii.
250.

* Ann. de
Chim. xxv.
259.

252
G. III.
Oxides of
antimony.

Ores of Bismuth.

GENUS IV. SALTS OF ANTIMONY.
SPECIES I. Muriat of antimony*.

This ore, which has been found in Bohemia, is sometimes in quadrangular tables; sometimes in acicular crystals grouped like zeolites; and sometimes in prisms. Colour pale yellowish or greyish white. Lustre 3 to 1, nearly metallic. Transparency 2. Texture foliated. Melts easily by the flame of a candle, and emits a white vapour†. Before the blow-pipe decrepitates; when powdered, and just ready to melt, it evaporates, and leaves a white powder around. Between two pieces of coal it is reducible to a metallic state.

* Kirw. ii. 251.
† Hauy, Jour. de Min. N^o xxxii. 609.

A specimen, analysed by Klaproth, contained
95 bismuth,
5 sulphur.
100†

Metallic Ores.

It is commonly accompanied by quartz, asbestos, or sparry iron ore.

GENUS III. OXIDES OF BISMUTH.
SPECIES I. Yellow oxide of bismuth†.
Bismuth ochre.

256
G. III. Oxides. Yellow oxide of bismuth. † Beitrage, i. 256.

This ore generally accompanies the two species already described. It is found in two states; either of an earthy consistence, or crystallized in cubes or quadrangular plates.

Colour usually greenish yellow, sometimes grey. Soluble in nitrous acid without effervescence, and may in a great measure be precipitated by the effusion of water.

ORDER XI. ORES OF BISMUTH*.

BISMUTH is employed in the manufacture of pewter, of printers types, in foldering; and perhaps also its property of rendering other metals more fusible, might make it useful in anatomical injections. The quantity consumed in commerce is not great.

It has been found only in the primitive mountains, and is by no means common. When unaccompanied by any other metal, it does not form veins, but kidney-form masses. It often accompanies cobalt. Its gangue is commonly quartz. Its ores are not very abundant. They have been found chiefly in Sweden, Norway, Transylvania, Germany, France, and England.

GENUS I. ALLOYS OF BISMUTH.
SPECIES I. Native bismuth*.

This mineral, which is found at Schneeberg, Johangeorgentadt, &c. in Germany, has commonly the form of small plates lying above one another. Sometimes it is crystallized in four-sided tables, or indistinct cubes.

Colour white with a shade of red; surface often tarnished red, yellow, or purple. Lustre metallic, 3 to 2. Opaque. Texture foliated or striated. Hardness 6. Sp. gr. 9.022† to 9.57†. Exceedingly fusible. Before the blow-pipe gives a silvery white bead, and at last evaporates in a yellowish white smoke, which is deposited on the charcoal.

It is generally accompanied by cobalt, and sometimes contains arsenic.

GENUS II. SULPHURETS OF BISMUTH.
SPECIES I. Common sulphuret of bismuth*.

This ore, which is found in Sweden, Saxony, and Bohemia, occurs sometimes in amorphous masses, and sometimes in needleform crystals.

Colour commonly bluish grey, sometimes white; surface often tarnished yellow, red, and purple. Powder black and shining. Lustre metallic, 2 to 3. Streak obscurely metallic. Texture foliated. Hardness 5. Brittle. Sp. gr. 6.131† to 6.4672†. When held to the flame of a candle, it melts with a blue flame and sulphureous smell. Before the blow-pipe emits a reddish yellow smoke, which adheres to the charcoal. This powder becomes white when it cools, and resumes its former colour when the flame is directed upon it*.

This ore, according to Sage, contains 60 bismuth. And, according to La Perouse, it holds 36 sulphur.

ORDER XII. ORES OF ARSENIC.

ARSENIC is used as an alloy for several other metals, especially copper. It is sometimes employed to facilitate the fusion of glass, or to render it opaque, in order to form an enamel. Preparations of arsenic are employed as paints; and, like most other violent poisons, it has been introduced into medicine.

This metal is scattered in great abundance over the mineral kingdom, accompanying almost every other metal, and forming also sometimes peculiar veins of its own. Of course it occurs in almost every species of mountain, and is accompanied by a variety of gangues.

GENUS I. ALLOYS OF ARSENIC.
SPECIES I. Native arsenic†.

257
G. I. Alloys. Native arsenic. † Kirw. ii.

This mineral is found in different parts of Germany. It occurs generally in masses of various shapes, kidney-form, botryoidal, &c.

Colour that of steel. Its surface quickly becomes tarnished by exposure to the air. Lustre metallic (when fresh), 2 to 3. Streak bluish grey, metallic, and bright. Powder dull and black. Texture compact. Hardness 7 to 8. Brittle. Sp. gr. 5.67† to 5.7249†. Gives an arsenical smell when struck. Before the blow-pipe emits a white smoke, diffuses a garlic smell, burns with a blue flame, gradually evaporates, depositing a white powder.

It is always alloyed with some iron, and often contains silver, and sometimes gold.

GENUS II. SULPHURETS OF ARSENIC.
SPECIES I. Orpiment (P).
Auripigmentum.

§ De Born: Catal. of M. Raab. ii. 194.

This ore, which is found in Hungary, Wallachia, Georgia, and Turkey in Asia, is either massive or crystallized. The crystals are confused, and their figure cannot be easily determined; some of them appear octohedrons, and others minute four-sided prisms.

Its colour is yellow. Streak orange yellow. Lustre waxy, 2 to 3. Transparency from 0 to 2. Texture foliated. Hardness 4 to 8. Sp. gr. from 3.048* to 3.521†. Effervesces with hot nitric acid. Burns with

258
G. II. Sulphurets. Orpiment. * Kirwans. † Gillette.

(P) Kirw. II. 260.—Alberti de Auripigmento.—Scopoli in Anno 5to Hist. Naturali, p. 59.—Berg. II. 297.

Ores of Arseniat. a bluish white flame. Before the blow-pipe melts, smokes, and evaporates, leaving only a little earth and some traces of iron.

Composed of 80 sulphur,
20 arsenic.

100

259

Realgar.

SPECIES 2. Realgar *.

* Kirw. ii. 261.—Berg. vius, in Hungary, Transylvania, and various parts of Germany. It is either massive or crystallized. The primitive form of the crystals is, according to Romé de Lisle, a four-sided rhomboidal prism, terminated by four-sided pyramids, the sides of which are rhombs †. It commonly appears in 4, 6, 8, 10, or 12 sided prisms, terminated by four-sided summits ‡.

† Crystall.

iii. 34.

‡ Ibid.

Colour red. Streak yellowish red. Powder scarlet. Lustre 3 to 2. Transparency from 2 to 3; sometimes 0. Hardness 5 to 6. Sp. gr. 3.3384 ‡. It is an electric *per se*, and becomes negatively electric by friction ||. Nitric acid deprives it of its colour. Before the blow-pipe it melts easily, burns with a blue flame and garlic smell, and soon evaporates.

§ Brisson.

|| Haüy,

four. de

Min. No

xxxii. 612.

Composed of 20 sulphur,
80 arsenic.

100

260

G. III.

Oxides.

White

oxide of

arsenic.

* Kirw. ii.

258.—Berg.

ii. 285.

† Kirwan.

GENUS III. OXIDES OF ARSENIC.

SPECIES I. White oxide of arsenic *.

Native calx of arsenic.

This ore is found in various parts of Germany, Hungary, &c. either in powder, or massive, or crystallized in prismatic needles.

Colour white or grey, often with a tint of red, yellow, green, or black. Lustre common, 1 to 2. Transparency 1 to 0; when crystallized, 2. Texture earthy. Hardness 6. Brittle. Sp. gr. 3.7 †. Soluble in hot diluted nitric acid without effervescence. Soluble at 60° Fahrenheit in 80 times its weight of water. Before the blow-pipe sublimes, but does not inflame. Tinges borax yellow.

ORDER XIII. COBALT ORES.

COBALT is employed to tinge glass of a blue colour, and is useful in painting upon porcelain.

Cobalt ores are found almost exclusively in the stratified mountains, except one species, sulphuret of cobalt, which affects the primitive mountains. They are not very abundant; and for that reason cobalt is more valuable than many of the other metals which have been already treated of. They are commonly accompanied by nickel, bismuth, or iron. They are most abundant in Germany, Sweden, Norway, and Hungary; they have been found also in Britain and France, but not in any great quantity.

261

G. I. Alloys.

Cobalt al-

loyed with

arsenic.

† Kirw. ii.

270.

‡ Romé de

Lisle, iii.

123.

GENUS I. ALLOYS OF COBALT.

SPECIES I. Cobalt alloyed with arsenic †.

Dull grey cobalt ore.

This ore, which occurs in different parts of Germany, is either amorphous or crystallized. The forms of its crystals are the cube; sometimes the cube with its angles, or edges, or both wanting; and the octahedron ‡.

Its colour, when fresh broken, is whitish or bluish grey, sometimes with a shade of red; when exposed to the air it soon becomes tarnished. Streak bluish grey and metallic. Lustre scarcely metallic, 0 to 1. Texture compact. Hardness 10. Difficultly frangible. Sp. gr. when amorphous, 5.309 to 5.571 §; when crystallized 7.7207 †. When struck it gives out an arsenical smell. Before the blow-pipe it gives out an arsenical vapour, becomes magnetic, and melts easily, unless it contains a great quantity of iron. Tinges borax dark blue, and a small metallic bead is obtained.

A specimen of this ore from Cornwall, examined by Mr Klaproth, contained 20 cobalt,

24 iron,
33 arsenic.

77

with some bismuth and stony matter *.

Another specimen from Tunaberg, according to the analysis of the same chemist, contained

55.5 arsenic,
44.0 cobalt,
.5 sulphur.

100 †

GENUS II. SULPHURETS OF COBALT.

SPECIES I. White cobalt ore ‡.

Sulphuret of cobalt, arsenic, and iron.

The descriptions which different mineralogists have given of this ore are so various, that it is impossible not to suppose that distinct substances have been confounded together.

It occurs either in masses, or crystallized in cubes, 33-dodecahedrons, octahedrons, and icosaedrons.

Colour tin white, sometimes tarnished reddish or yellowish. Lustre steel grey. Lustre partly metallic, and from 2 to 4; partly 0 or 1. Texture foliated. Hardness 8 to 9. Sp. gr. from 6.284 † to 6.4509 ‡. Before the blow-pipe generally gives out an arsenical vapour, and does not melt.

The analyses that have been given of this ore are very various. Sometimes it has been found to contain no arsenic nor iron, and sometimes to contain both. A specimen from Tunaberg in Sweden, which ought to belong to this species, was analysed by Tassaert, and found to consist of

49 arsenic,
36.6 cobalt,
5.6 iron,
6.5 sulphur.

97.7 †

Klaproth found a specimen of the same ore to contain

55.5 arsenic,
44.0 cobalt,
0.5 sulphur.

100.0 ‡

GENUS III. OXIDES OF COBALT.

SPECIES I. Black cobalt ore or ochre §.

This ore, which occurs in different parts of Germany, is either in the form of powder, or indurated.

Colour black, often with a shade of blue, grey, brown, or green. Lustre 0 to 1. Streak brighter. Hardness (of the indurated) from 4 to 8. Sp. gr. 3 to 4. Soluble in muriatic acid. Tinges borax blue.

SPECIES

Metallic Ores.

Kirw. ii.

270.

Haüy,

four. de

Min. No

xxxii. 388.

Klaproth's

Cornwall,

p. 61.

† Beiträge,

ii. 307.

262

G. II. Sul-

phurets.

White co-

balt ore.

† Kirw. ii.

273.—Sage,

four. de

Pby. xxxix.

Order XIV.

MINERALOGY.

247

Ores of Nickel.
SPECIES 2. Brown cobalt ore *.
Colour greyish or dark leather brown. Streak brighter, unctuous. Communicates a pale blue tinge in fusion.
294 Brown cobalt ore.
* Kirwan, ii. 276.
265 Yellow cobalt ore.
† Ibid.
266 G. IV. Salts.
Arseniat of cobalt.
† Id. 278.

acids and by ammonia. The acid solution is green; the alkaline blue.

Metallic Ores
269
G. III. Salts.
Arseniat of nickel.
† Kirwan, ii. 285.

GENUS IV. SALTS OF COBALT.
SPECIES 1. Arseniat of cobalt †.
Red cobalt ore.
This species, like most other ores of cobalt, has neither been accurately described nor analysed.
It is found in masses of various shapes, and crystallized in quadrangular tables or acicular prisms.
Colour red. Lustre from 2 to 3, sometimes 0. Transparency 0 to 2. Hardness 5 to 7. Brittle. Before the blow-pipe becomes blackish grey. Diffuses a weak arsenical smell. Tinges borax blue.

GENUS III. SALTS OF NICKEL.
SPECIES 1. Arseniat of nickel †.
This ore, which was lately discovered at Regendorff by Mr Gmelin, is found in shapeless masses, and is often mixed with plates of sulphat of barytes.
Colour pale grey, here and there mixed with pale green. Streak white. Lustre 0. Texture compact. Hardness 7. Difficultly frangible. Sp. gr. considerable. Adheres slightly to the tongue, and gives an earthy smell when breathed on. Soluble in hot nitric and muriatic acids: solution green.
Contains some cobalt and alumina.

ORDER XIV. ORES OF NICKEL.

HITHERTO nickel has been found in too small quantities to be applied to any use; of course there are, properly speaking, no mines of nickel. It occurs only (as far as is yet known) in the secondary mountains, and it commonly accompanies cobalt. It has been found in different parts of Germany, in Sweden, Siberia, Spain, France, and Britain.

ORDER XV. ORES OF MANGANESE (Q).

HITHERTO manganese, in its metallic state, has scarcely been put to any use; but under the form of an oxide it has become of great importance. The oxide of manganese has the property of rendering colourless a variety of bodies which injure the transparency of glass; and it has been long used in glass manufactories for this purpose under the name of *glass soap*. By means of the same oxide, oxy-muriatic acid is prepared, which has rendered manganese of great importance in bleaching. Not to mention the utility of manganese to the chemist, the property which it has of facilitating the oxidation of other metals, and of rendering iron more fusible—will probably make it, in no very remote period, of very considerable importance in numerous manufactories.

GENUS I. SULPHURETS OF NICKEL.
SPECIES 1. Sulphuret of nickel with arsenic and iron.
Kupfer nickel*.
This, which is the most common ore of nickel, occurs either massive or disseminated, but never crystallized.
Colour often that of copper, sometimes yellowish white or grey. Recent fracture often silver white. Lustre metallic, 2 to 3. Texture compact. Hardness 8. Sp. gr. 6.6086 to 6.6481 †. Soluble in nitric and nitro-muriatic acids. Solution green. Before the blow-pipe exhales an arsenical smoke, and melts into a bead which darkens by exposure to the air.
It is composed of various proportions of nickel, arsenic, iron, cobalt, sulphur; often contains bismuth, and sometimes silver and copper.

Ores of manganese occur often in strata, both in the primitive and secondary mountains; scarcely ever, however, we believe, in those mountains which are considered as the most ancient of all. They are very common, having been found abundantly in Germany, France, Spain, Britain, Sweden, Norway, Siberia, and other countries.

GENUS II. OXIDES OF NICKEL.
SPECIES 1. Nickel ochre*.
This mineral occurs either in the form of a powder, or indurated, and then is either amorphous, or crystallized in acicular form crystals. The powder is generally found on the surface of other nickel ores.
Colour different shades of green. Lustre 1 to 0. Texture earthy. Sp. gr. considerable. Slowly dissolves in acids: solution green. Before the blow-pipe does not melt; but gives a yellowish or reddish brown tinge to borax.
This ore often contains sulphat of nickel, which is soluble in water. The solution, when evaporated, gives oblong rhomboidal crystals, from which alkalies precipitate a greyish green oxide. This oxide is soluble by

GENUS I. OXIDES OF MANGANESE.
Hitherto manganese has only been found in the state of oxide. La Perouse, indeed, suspected that he had found it in a metallic state: but probably there was some mistake or other in his observations.

270
G. I. Oxides.
271
Oxide of manganese combined with barytes.

SPECIES 1. Oxide of manganese combined with barytes.
This species, which exists in great abundance in Romanche near the river Soane in France, is found massive, forming a stratum in some places more than 12 fathoms thick.
Colour greyish black or brownish black, of great intensity. Lustre, external, 0; internal, metallic, 1. Soon tarnishes by exposure to the air, and then becomes intensely black. Texture granular. Fracture uneven; sometimes conchoidal. Often porous. Hardness 11. Difficultly frangible. Sp. gr. from 3.950 to 4.10. Absorbs water. When taken out of water after a minute's immersion it has a strong argillaceous smell. Conducts electricity nearly as well as if it were in a metallic state. Infusible by the blow-pipe. Tinges soda red; the colour disappears before the blue cone of flame, and is reproduced by the action of the yellow flame.

From

(Q) Pott, Miscelan. Berolens, VI. 40.—Margraff, Mem. Berlin, 1773, p. 3.—La Perouse, Jour. de Phys., XVI. 156. and XV. 67. and XXVIII. 68.—Sage, Mem. Par. 1785, 235.

Ores of Manganese. From the analysis of Vauquelin, it appears that it is composed of

50.0	white oxide of manganese,
33.7	oxygen,
14.7	barytes,
1.2	silica,
.4	charcoal.

¶ Dolomieu,
Jour. de
Min. N°
xix. 42.

272
Grey ore of
manganese.
* Kirwan,
ii. 291.

† Vauquelin.
† Briffon.

§ Jour. de
Min. N°
xvii. 13.

273
Black or
brown ore
of manga-
nese.
* Kirwan,
ii. 192.—
Wedgewood,
Phil. Trans.
lxxxiii. 284.

274
G. II. Salts.
Carbonat
of manga-
nese.
† Kirwan,
ii. 297.

SPECIES 2. Grey ore of manganese *.
This ore occurs both massive and disseminated: it is also sometimes crystallized in slender four-sided prisms or needles.
Colour usually dusky steel grey; sometimes whitish grey, or reddish grey. Streak and powder black. External lustre 3 to 2; internal metallic, 2 to 1. Texture striated or foliated. Hardness 4 to 5. Brittle. Sp. gr. from 4.073 † to 4.8165 ‡. Before the blow-pipe darkens. Tinges borax reddish brown.

A specimen of oxide of manganese from the mountains of Vosges, which probably belonged to this species, and which was analysed by Vauquelin, was composed of

82	oxide of manganese,
7	carbonat of lime,
6	silica,
5	water.

100 §

Sometimes it contains a little barytes and iron.

SPECIES 3. Black or brown ore of manganese *.
This ore is found sometimes in the state of powder, and sometimes indurated in amorphous masses of various figures. Colour either black, sometimes with a shade of blue or brown; or reddish brown. Streak of the harder sorts metallic; of the others, black. Lustre 0 to 1; internal (when it is indurated), metallic. Texture compact. Hardness 5 to 7. Sp. gr. 3.7076 to 3.9039; that of the powdery sometimes only 2. Before the blow-pipe it exhibits the same phenomena as the last species.

A specimen of this ore, analysed by Westrum, contained

45.00	manganese,
14.00	oxide of iron,
11.00	silica,
7.25	alumina,
2.00	lime,
1.50	oxide of copper,
18.00	air and water.

98.75

GENUS II. SALTS OF MANGANESE.

SPECIES I. Carbonat of manganese †.

White ore of manganese.

This species occurs in Sweden, Norway, and Transylvania. It is either in the form of loose scales, or massive, or crystallized in needles.

Colour white, or reddish white. Texture either radiated or scaly. Lustre of the scaly 2. Transparency 1 to 2. Hardness of the massive 6 to 9. Sp. gr. 2.794. Effervesces with mineral acids. Heated to redness, blackens. Tinges borax violet.

SPECIES 2. Red ore of manganese †.

Carbonat of manganese and iron.

This species has been found in Piedmont and in the Pyrenees: It is sometimes in powder, sometimes massive, sometimes crystallized in rhomboidal prisms or needles.

Colour pale rosy red, mixed with white. Powder nearly white. Lustre 0. Transparency 1. Hardness 8. Sp. gr. 3.233. Effervesces with nitric and muriatic acids. When heated to redness becomes reddish brown. Tinges borax red.

A specimen, analysed by Ruprecht, contained

55.0	silica,
25.0	oxide of manganese,
7.0	oxide of iron,
1.5	alumina.

98.5 §

Metallic
Ores.

275
Red ore of
manganese.
† Kirwan,
ii. 297.—
Napien,
Mem. Tur-
rin, iv. 303.

§ Jour. de
Phys. xxxi.
22.

ORDER XVI. ORES OF TUNGSTEN.

As no easy method has hitherto been discovered of reducing tungsten to a metallic state, we need not be surprised that it has been applied to no use. Ores of tungsten are by no means common. They have hitherto been found only in the primitive mountains. Their gangue is commonly quartz. They very often accompany tin ores.

GENUS I. OXIDES OF TUNGSTEN.

SPECIES I. Wolfram (R).

Oxides of tungsten, iron, and manganese—Tungstat of iron and manganese.

This species is found in different parts of Germany, in Sweden, Britain, France and Spain; and is almost constantly accompanied by ores of tin. It occurs both massive and crystallized. The primitive form of its crystals, according to the observations of Mr Haüy, is a rectangular parallelepiped †, whose length is 8.66, whose † Fig. 42. breadth is 5, and thickness 4.33 *. It is not common, * Jour. de however, to find crystals of this perfect form; in many Min. N° cases, the angles, and sometimes the edges, of the cry- xix. 8. stal are wanting †; owing, as Mr Haüy has shewn, to † Fig. 42. the superposition of plates, whose edges or angles decrease according to a certain law †.

Colour brown or brownish black. Streak reddish brown. Powder stains paper with the same colour. Lustre external, 2; internal, 2 to 3; nearly metallic. Texture foliated. Easily separated into plates by percussion. Hardness 6 to 8. Sp. gr. from 7.006 * to * Kirwan. 7.333 †. Moderately electric by communication. Not † Haüy. magnetic. Infusible by the blow-pipe. Forms with borax a greenish globule, and with microcosmic salt a transparent globule of a deep red ¶.

The specimen of this ore, examined by Messrs d'Elhuyart's, was composed of

65	oxide of tungsten,
22	oxide of manganese,
13	oxide of iron.

100

Another

(R) Kirw. II. 316.—De Luyart, Mem. Thoulouse, II. 141.—Gmelin, Crelle's Jour. English Transf. III. 127, 205, and 293.—La Perouse, Jour. de Min. N° IV. p. 23.

Ores of
Molybde-
num.

Another specimen from Pays le Mines in France, analysed by Vauquelin and Hecht, contained

67.00 oxide of tungsten,
18.00 black oxide of iron,
6.25 black oxide of manganese,
1.50 silica,
7.25 oxide of the iron and manganese.

§ Vauquelin,
Jour. de
Min. N^o
xix. 11.

100.00 §

GENUS II. SALTS OF TUNGSTEN.

SPECIES I. Tungstat of lime (s).

Tungsten.

277
G. II. Salts.
Tungstat of
lime.

This ore, which is now exceedingly scarce, has hitherto been found only in Sweden and Germany. It is either massive or crystallized; and, according to Haüy, the primitive form of its crystals is the octahedron †.

† Jour. de
Min. N^o
xxxiii. 657.

Colour yellowish white or grey. Lustre 3 to 2. Transparency 2 to 3. Texture foliated. Hardness 6 to 9. Sp. gr. 5.8 to 6.0665. Becomes yellow when digested with nitric or muriatic acids. Infusible by the blow-pipe. With borax forms a colourless glass, unless the borax exceed, and then it is brown. With microcosmic salt it forms a blue glass, which loses its colour by the yellow flame, but recovers it in the blue flame †.

† Scheele and
Bergman.

It is composed of about 70 oxide of tungsten,
30 lime.

100

§ Scheele.

with a little silica and iron §.

278
Brown
tungstat.

SPECIES 2. Brown Tungstat.

This ore is found in Cornwall, and is either massive or composed of small crystalline grains.

Colour grey, variegated with yellow and brown. Lustre 2, waxy. Hardness 6 to 7. Sp. gr. 5.57. Its powder becomes yellow when digested in aqua regia.

According to Klaproth, it is composed of

88.0 oxide of tungsten,
11.5 lime.

99.5

ORDER XVII. ORES OF MOLYBDENUM.

If ever molybdenum be found in abundance, it will probably be useful in dyeing and painting. At present it is very scarce, having only been found in Sweden, Germany, Carniola, and among the Alps. Like tin and tungsten, it affects the primitive mountains.

279
G. I. Sulphuret.
Common
sulphuret.

GENUS I. SULPHURET OF MOLYBDENUM.

SPECIES I. Common sulphuret (τ).

Molybdena.

This ore, which is the only species of molybdenum ore at present known, is found commonly massive; sometimes, however, it is crystallized in hexahedral tables.

Colour light lead grey; sometimes with a shade of red. Streak bluish grey, metallic. Powder bluish. Lustre metallic, 3 to 2. Texture foliated. Lamellæ slightly flexible. Hardness 4. Sp. gr. 4.569* to

* Karsten.
† Briffon.

4.7385 †. Feels greasy; stains the fingers. Marks

SUPPL. VOL. II. Part I.

bluish black. A piece of resin rubbed with this mineral becomes positively electric †. Insoluble in sulphuric and muriatic acids; but in a boiling heat colours them green. Effervesces with warm nitric acid, leaving a grey oxide undissolved. Before the blow-pipe, on a silver spoon, emits a white smoke, which condenses into a white powder, which becomes blue in the internal, and loses its colour in the external, flame. Scarcely affected by borax or microcosmic salt. Effervesces with soda, and gives it a reddish pearl colour.

Composed of about 60 molybdenum,
40 sulphur.

100 *

Metallic
Ores.

† Haüy,
Jour. de
Min. N^o
xix. 70.

* Klaproth.

ORDER XVIII. ORES OF URANIUM.

URANIUM has hitherto been found only in Germany, and has not been applied to any use. The only two mines where it has occurred are in the primitive mountains.

GENUS I. OXIDES OF URANIUM.

SPECIES I. Sulphuret of uranium †.

Pecblend.

280
G. I. Oxides.
Sulphuret
of uranium.
† Kirwan,
ii. 305.

This ore, which has been found at Johanngeorgenstadt in Saxony, and Joachimsthal in Bohemia, is either massive or stratified with other minerals.

Colour black or brownish black; sometimes with a shade of grey or blue. Streak darker. Powder opaque and black. Lustre semimetallic, from 3 to 1. Fracture conchoidal. Hardness 7 to 8. Very brittle. Sp. gr. from 6.3785 † to 7.5, and even higher §. Imperfectly soluble in sulphuric and muriatic acids; perfectly in nitric acid and aqua regia. Solution wine yellow. Infusible with alkalies in a crucible; infusible by the blow-pipe *per se*. With borax and soda forms a grey opaque slag; with microcosmic salt, a green glass.

Composed of oxide of uranium and sulphur, and mixed with iron and silica, and sometimes lead.

A specimen of this ore from Joachimsthal, analysed lately by Klaproth, contained

86.5 uranium,
6.0 sulphuret of lead,
5.0 silica,
2.5 oxide of iron.

100.0 *

SPECIES 2. Yellow oxide of uranium †.

Uranitic ochre.

This ore is generally found on the surface of the last species at Johanngeorgenstadt, and is either massive or in powder.

Colour yellow, red, or brown. Streak of the yellow sorts yellow; of the red, orange yellow. Lustre 0. Slightly stains the fingers. Feels meagre. Texture earthy. Hardness 3 to 4. Sp. gr. 3.2438 †. Infusible by the blow-pipe; but in a strong heat becomes brownish grey.

Composed of oxide of uranium and oxide of iron.

I i

GENUS

* Beiträge,
ii. 221.

281
Yellow
oxide of
uranium.
† Kirwan,
ii. 303.

† Haüy,
Jour. de
Min. *ibid*

(s) Airw. II. 314.—Scheele's Works (French translation), II. 81.—Bergman, *ibid*. p. 94.—Crell, *Chem. Annalen*. 1784, 2. Bard 195.

(τ) Kirw. II. 322.—Scheele's Works (French translation), I. 236.—Pelletier, *Jour. de Phys.* XXVII. 434.—Hfemann, *ibid*. XXXIII. 292.—Sage, *ibid*. 389.—Klaproth and Mudeer, *Ann. de Chim.* III. 120.

Ores of
Titanium.

282

G. II. Salts

Carbonat

of uranium

¶ Kirwan,

ii. 304.

§ Gmelin.

GENUS II. SALTS OF URANIUM.

SPECIES I. Carbonat of uranium ¶.

This substance is also found at Johanngeorgenstadt, and near Eibentz and Rheinbreidenbach §. It is sometimes amorphous, but more commonly crystallized. Its crystals are square plates, octahedrons, and six sided prisms.

Colour green; sometimes nearly white; sometimes, though rarely, yellow. Streak greenish white. Lustre 3 to 2; internal, 2; sometimes pearly; sometimes nearly metallic. Transparency 2 to 3. Texture foliated. Hardness 5 to 6. Brittle. Soluble in nitric acid without effervescence. Infusible by alkalis.

Composed of carbonat of uranium, with some oxide of copper. When its colour is yellow it contains no copper.

ORDER XIX. ORES OF TITANIUM.

TITANIUM has been known for so short a time, and its properties are yet so imperfectly ascertained, that many of its uses must remain to be discovered. Its oxide, as we learn from Mr Darcet, has been employed in painting on porcelain *. Hitherto it has been found only in the primitive mountains, the Crapacks †, the Alpes (u), and the Pyrenees ‡. It has been found also in Brittany || and in Cornwall.

* Four. de
Min. N°

xv. 27.

† Ibid. N°

xii. 51.

‡ Four. de

Min. N°

xxxii. 614.

|| Ibid.

283

G. I. Oxides.

Red oxide

of titanium.

GENUS I. OXIDES OF TITANIUM.

SPECIES I. Red oxide of Titanium.

Red borl—Sagenite.

This ore has been found in Hungary, the Pyrenees, the Alpes, and in Brittany in France. It is generally crystallized. The primitive form of its crystals, according to the observations of Mr Haüy, is a rectangular prism, whose base is a square; and the form of its molecules is a triangular prism, whose base is a right angled isosceles triangle, and the height is to any of the sides of the base about the right angle as $\sqrt{12}$ to $\sqrt{5}$, or nearly as 3 : 2 ¶. Sometimes the crystals of titanium are six-sided, and sometimes four-sided, prisms, and often they are implicated together †.

Colour red or brownish red. Powder brick or orange red. Lustre 3. Transparency commonly 0; sometimes 1. Texture foliated. Hardness 9. Brittle. Sp. gr. from 4.18 * to 4.2469 †. Not affected by the mineral acids. When fused with carbonat of potash, and diluted with water, a white powder precipitates, heavier than the titanium employed. Before the blow-pipe it does not melt, but becomes opaque and brown. With microcosmic salt it forms a globule of glass, which appears black; but its fragments are violet. With borax it forms a deep yellow glass, with a tint of brown. With soda it divides and mixes, but does not form a transparent glass.

* Klaproth

† Vauquelin

and Hecht.

When pure, it is composed entirely of oxide of titanium.

284
Menachanite.

SPECIES 2. Menachanite (x).

Oxide of titanium combined with iron.

This substance has been found abundantly in the valley of Menachan in Cornwall; and hence was called me-

nachanite by Mr Gregor, the discoverer of it. It is in small grains, like gunpowder, of no determinate shape, and mixed with a fine grey sand. Colour black. Easily pulverized. Powder attracted by the magnet. Sp. gr. 4.427. Does not detonate with nitre. With two parts of fixed alkali it melts into an olive coloured mass, from which nitric acid precipitates a white powder. The mineral acids only extract from it a little iron. Diluted sulphuric acid, mixed with the powder, in such a proportion that the mass is not too liquid, and then evaporated to dryness, produces a blue coloured mass. Before the blow-pipe does not decrepitate nor melt. It tinges microcosmic salt green; but the colour becomes brown on cooling: yet microcosmic salt does not dissolve it. Soluble in borax, and alters its colour in the same manner.

According to the analysis of Mr Gregor, it is composed of

46 oxide of iron,
45 oxide of titanium.

According to Mr Klaproth's analysis, it is composed of

91 with some silica and manganese †. † M. Gregor's
51.00 oxide of iron, Four. de
45.25 oxide of titanium, Phys. xxxix.
3.50 silica, 72. 152.
.25 oxide of manganese.

100.00 ‡

A mineral, nearly of the same nature with the one just described, has been found in Bavaria. Its specific gravity, however, is only 3.7. According to the analysis of Vauquelin and Hecht, it is composed of

49 oxide of titanium,
35 iron,
2 manganese,
14 oxygen combined with the iron and manganese.

100 §

SPECIES 3. Calcareo-siliceous ore of titanium.

Oxide of titanium combined with lime and silica—Titanite †. This ore has hitherto been found only near Passau. It was discovered by Professor Hunger. It is sometimes massive, but more commonly crystallized in four-sided prisms, not longer than one fourth of an inch.

Colour reddish, yellowish, or blackish brown; sometimes whitish grey. Powder whitish grey. Lustre waxy or nearly metallic, 2 to 3. Transparency from 0 to 2. Texture foliated. Hardness 9 or more. Brittle. Sp. gr. 3.510. Muriatic acid, by repeated digestion, dissolves one-third of it. Ammonia precipitates from this solution a clammy yellowish substance. Infusible by the blow pipe, and also in a clay crucible; but in charcoal is converted into a black opaque porous slag.

According to the analysis of Klaproth, it is composed of

33 oxide of titanium,
35 silica,
33 lime.

101

ORDER

(u) Dolomieu, Four. de Min. N° XLII. 431. and Saussure, Voyages, N° 1894.
(x) Kirwan, II. 326.—Gregor, Four. de Phys. XXXIX. 72. and 152.—Schmeisser, Crell's Annals (English translation), III. 252.

Order XX.

MINERALOGY.

251

Ores of
Tellurium.

ORDER XX. ORES OF TELLURIUM.

HITHERTO tellurium has only been found in Transylvania. It occurs in three different mines; that of Fatzbay, Offenbanya, and Nagyag, which are considered as gold mines, because they contain less or more of that metal. Its gangue is commonly quartz.

286
G. I. Alloys.
White gold
ore of Fatz-
bay.

GENUS I. ALLOYS OF TELLURIUM.
SPECIES 1. White gold ore of Fatzbay.
Alloy of tellurium and iron, with some gold.

This species is generally massive. Its colour is between tin white and lead grey. Lustre considerable, metallic. Texture granular*.

* Ann. de
Chim. xxv.
327.

According to Klaproth's analysis, it is composed of
72.0 iron,
25.5 tellurium,
2.5 gold.

† Ibid. 280.

100.0 †

287
Graphic
golden ore
of Offen-
banya.

SPECIES 2. Graphic golden ore of Offenbanya.
Tellurium alloyed with gold and silver.

This ore is composed of flat prismatic crystals; the arrangement of which has some resemblance to Turkish letters. Hence the name of the ore.

† Ann. de
Chim. xxv.
328.

Colour tin white, with a tinge of brass yellow †. Lustre metallic, 3. Hardness 4 to 5. Brittle. Sp. gr. 5.723. Before the blow-pipe decrepitates, and melts like lead. Burns with a lively brown flame and disagreeable smell, and at last vanishes in a white smoke, leaving only a whitish earth †.

‖ De Born,
Kirwan's
Min. ii.
110.

According to Klaproth's analysis it is composed of
60 tellurium,
30 gold,
10 silver.

§ Ann. de
Chim. xxv.
280.

The yellow gold ore of Nagyag would belong to this species were it not that it contains lead. Its composition, according to Klaproth's analysis, is as follows:

45.0 tellurium,
27.0 gold,
19.5 lead,
8.5 silver,

* Ibid.

288
Grey foliated
gold ore
of Nagyag.

SPECIES 3. Grey foliated gold ore of Nagyag.

This ore is found in plates, of different degrees of thickness, adhering to one another, but easily separable; these are sometimes hexahedral, and often accumulated so as to leave cells between them.

Colour deep lead grey, passing to iron black, spotted. Lustre metallic, moderate. Texture foliated; leaves slightly flexible †. Hardness 6. Sp. gr. 8.919. Stains the fingers. Soluble in acids with effervescence †.

† Klaproth,
Ann. de
Chim. xxv.
329.

According to Klaproth, it is composed of

† De Born,
Kirwan's
Min. ii. 99.

50.0 lead,
33.0 tellurium,
8.5 gold,
7.5 sulphur,
1.0 silver and copper.

§ Ann. de
Chim. ibid.
280.

100.0 §

ORDER XXI. ORES OF CHROMUM.

Metallic
Ores.

CHROMUM has hitherto been found in too small quantities for its extensive application to the arts. Whenever it becomes plentiful, its properties will render it of great importance both to the dyer and painter. Nature has used it to colour some of her most beautiful mineral productions: And can art copy after a better model? Hitherto it has been found only in two places, near Ekaterinbourg in Siberia, and in the department of the Var in France. In the first of these places, and probably also in the second, its gangue is quartz.

GENUS I. SALTS OF CHROMUM.

SPECIES 1. Chromat of lead.

Red lead ore of Siberia.

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G. I. Salts.
Chromat of
lead.

This singular mineral, which has now become scarce, is found in the gold mines of Berefof near Ekaterinbourg in Siberia, crystallized in four-sided prisms, sometimes terminated by four-sided pyramids, sometimes not.

Colour red, with a shade of yellow. Streak and powder a beautiful orange yellow. Lustre from 2 to 3. Transparency 2 to 3. Structure foliated. Texture compact. Fracture uneven. Hardness 5 to 4. Sp. gr. 6.0269 † to 5.75 †. Does not effervesce with acids. Before the blow-pipe decrepitates; some lead is reduced, and the mineral is converted to a black slag, which tinges borax green.

According to the analysis of Vauquelin, it is composed of

65.12 oxide of lead,
34.88 chromic acid.

100.00 ‖.

SPECIES 2. Chromat of iron.

This mineral, which has been found only near Gasfin in the department of Var in France, is in irregular masses.

Colour brown, not unlike that of brown blende. Lustre metallic. Hardness moderate. Sp. gr. 4.0326. Melts with difficulty before the blow-pipe; to borax it communicates a dirty green. Insoluble in nitric acid. Melted with potash, and dissolved in water, the solution assumes a beautiful orange yellow colour.

It is composed of 63.6 chromic acid,
36.0 oxide of iron.

99.6 †

‖ Jour. de
Min. N°
xxxiv. 760.

290
Chromat of
iron.

CHAP. V. OF THE CHEMICAL ANALYSIS OF MINERALS.

† Tassaert,
Ann. de
Chim. xxxi.
220.

THE progress which the art of analysing minerals has made within these last twenty years is truly astonishing. To separate five or six substances intimately combined together, to exhibit each of them separately, to ascertain the precise quantity of each, and even to detect the presence and the weight of substances which do not approach $\frac{1}{100}$ th part of the compound, would, at no very remote period, have been considered as a hopeless, if not an impossible, task; yet this can now be done with the most rigid accuracy.

The first person who undertook the analysis of minerals was Margraff of Berlin. His attempts were indeed rude; but their importance was soon perceived by other chemists, particularly by Bergman and Scheele,

I 12

whose

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Analysis of
minerals.

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Analysis of Minerals.

293
Improved
by Klaproth

294
And other
chemists.

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Method of
obtaining
chemical a-
gents pure.

whose industry and address brought the art of analysing minerals to a considerable degree of perfection.

But their methods, though they had very considerable merit, and, considering the state of the science, are wonderful proofs of the genius of the inventors, were often tedious and uncertain, and could not in all cases be applied with confidence. These defects were perceived by Mr Klaproth of Berlin, who applied himself to the analysis of minerals with a persevering industry which nothing could fatigue, and an ingenuity and accuracy which nothing could perplex. He corrected what was wrong, and supplied what was wanting, in the analytical method; invented new processes, discovered new instruments; and it is to his labours, more than to those of any other chemist, that the degree of perfection, to which the analysis of minerals has attained, is to be ascribed. Many improvements, however, were introduced by other chemists, especially by Mr Vauquelin, whose analyses in point of accuracy and ingenuity rival those of Klaproth himself.

We shall, in this chapter, give a short description of the most perfect method of analysing minerals, as far as we are acquainted with it. We shall divide the chapter into four sections. In the first, we shall give an account of the instruments used in analyses; in the second, we shall treat of the method of analysing stones; in the third, of analysing combustibles; and in the fourth, of the analyses of ores.

SECT. I. Of the Instruments of Analyses.

I. The chymical agents, by means of which the analysis of minerals is accomplished, ought to be prepared with the greatest care, because upon their purity the exactness of the operation entirely depends. These agents are the three alkalies, both pure and combined with carbonic acid; the sulphuric, nitric, and muriatic acids; hydrofulphuret of potash and sulphurated hydrogen gas dissolved in water; prussic alkali, and a few neutral salts.

1. Potash and soda may be obtained pure, either by means of alcohol, or by the method described in the article CHEMISTRY, n° 372. *Suppl.* These alkalies are known to be pure when their solution in pure water occasions no precipitate in lime and barytic water; when the precipitate which it produces in a solution of silver is completely dissolved by nitric acid; and, lastly, when saturated with carbonic acid it deposits no silica.

2. Ammonia is procured by distilling one part of muriat of ammonia with two parts of quicklime, and receiving the gas in a dish containing a quantity of pure water, equal in weight to the muriat employed. Its purity is known by the same tests which ascertain the purity of fixed alkalies.

3. The carbonats of potash and soda may be formed by dissolving the potash and soda of commerce in pure water, saturating the solution with carbonic acid, and crystallizing them repeatedly. When pure, these crystals effloresce in the air; and the precipitate which they occasion in solutions of barytes and of silver is completely soluble in nitric acid. Carbonat of ammonia is obtained by distilling together one part of muriat of ammonia and two parts of carbonat of lime.

4. The sulphuric acid of commerce often contains nitric acid, potash, lead &c. It may be purified by distillation in a low cucurbit. The first portion, when

it comes over, must be set aside; it contains the nitric acid. The other impurities remain behind in the cucurbit. Sulphuric acid, when pure, dissolves indigo without altering its colour, does not attack mercury while cold, and causes no precipitate in pure alkaline solutions.

5. Nitric acid often contains both sulphuric and muriatic acids. It is easily purified by throwing into it about three parts of litharge in fine powder for every 100 parts of the acid, allowing the mixture to remain for 24 hours, shaking it occasionally, and then distilling it. The sulphuric and muriatic acids combine with the lead, and remain behind in the retort. Pure nitric acid occasions no precipitate in the solutions of barytes and silver.

6. The muriatic acid of commerce usually contains sulphuric acid, oxymuriatic acid, and oxide of iron. It may be purified by distillation with a little muriat of soda; taking care to set aside the first portion which comes over. When pure it causes no precipitate in the solution of barytes, nor of pure alkalies, and does not attack mercury while cold.

7. Hydrofulphuret of potash is made by saturating a solution of pure potash with sulphurated hydrogen gas; and water may be saturated with sulphurated hydrogen gas in the same manner. See CHEMISTRY, n° 857. *Suppl.*

8. The method of preparing prussic alkali, oxalic acid, and the other substances used in analyses, has been already described in the article CHEMISTRY, *Suppl.* it is unnecessary therefore to repeat it here.

II. Before a mineral is submitted to analysis, it ought to be reduced to an impalpable powder. This is by no means an easy task when the stone is extremely hard. It ought to be raised to a bright red or white heat in a crucible, and then instantly thrown into cold water. This sudden transition makes it crack and break into pieces. If these pieces are not small enough, the operation may be repeated on each till they are reduced to the proper size. These fragments are then to be beaten to small pieces in a polished steel mortar; the cavity of which should be cylindrical, and the steel pestle should fit it exactly, in order to prevent any of the stone from escaping during the act of pounding. As soon as the stone is reduced to pretty small pieces, it ought to be put into a mortar of rock crystal or flint, and reduced to a coarse powder. This mortar should be about four inches in diameter, and rather more than an inch in depth. The pestle should be formed of the same stone with the mortar, and care should be taken to know exactly the ingredients of which this mortar is composed. Klaproth's mortar is of flint. We have given its analysis in n° 32. of this article.

When the stone has been reduced to a coarse powder, a certain quantity, whose weight is known exactly, 100 grains for instance, ought to be taken and reduced to as fine a powder as possible. This is best done by pounding small quantities of it at once, not exceeding 10 grains. The powder is as fine as possible when it feels soft, adheres together, and as it were forms a cake under the pestle. It ought then to be weighed exactly. It will almost always be found heavier after being pounded than it was before; owing to a certain quantity of the substance of the mortar which has been rubbed off during the grinding and mixed with the powder.

Analysis of Minerals.

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How to re-
duce the
mineral to
powder.

²⁹⁷ **Analysis of Minerals.** This additional weight must be carefully noted; and after the analysis, a portion of the ingredients of the mortar, corresponding to it, must be subtracted.

²⁹⁷ **Chemical dishes.** III. It is necessary to have a crucible of pure silver, or, what is far preferable, of platinum, capable of holding rather more than seven cubic inches of water, and provided with a cover of the same metal. There should also be ready a spatula of the same metal about four inches long.

The dishes in which the solutions, evaporations, &c. are performed, ought to be of glass or porcelain. Those of porcelain are cheaper, because they are not so apt to break. Those which Mr Vauquelin uses are of porcelain; they are sections of spheres, and are glazed both within and without, except that part of the bottom which is immediately exposed to the fire.

SECT. II. *Analysis of Stones* (y).

²⁹⁸ **Ingredients of stones.** The only substances which enter into the composition of the simple stones, as far at least as analysis has discovered, are the six earths, silica, alumina, zirconia, glucina, lime, and magnesia; and the oxides of iron, manganese, nickel, chromium, and copper (z). Seldom more than four or five of these substances are found combined together in the same stone: we shall suppose, however, in order to prevent unnecessary repetitions, that they are all contained in the mineral which we are going to analyse.

²⁵⁹ **Method of decomposing stones.** Let 100 or 200 grains of the stone to be analysed, previously reduced to a fine powder, be mixed with three times its weight of pure potash and a little water, and exposed in the silver or platinum crucible to a strong heat. The heat should at first be applied slowly, and the matter should be constantly stirred, to prevent the potash from swelling and throwing any part out of the crucible. When the whole water is evaporated, the mixture should be kept for half an hour or three quarters in a strong red heat.

If the matter in the crucible melts completely, and appears as liquid as water, we may be certain that the stone which we are analysing consists chiefly of silica; if it remains opaque, and of the consistence of paste, the other earths are most abundant; if it remains in the form of a powder, alumina is the prevalent earth. If the matter in the crucible be of a dark or brownish red colour, it contains oxide of iron; if it is grass green, manganese is present; if it is yellowish green, it contains chromium.

When the crucible has been taken from the fire and wiped on the outside, it is to be placed in a capsule of porcelain, and filled with water. This water is to be renewed from time to time till all the matter is detached from the crucible. The water dissolves a part of the combination of the alkali with the silica and alumina of the stone; and if a sufficient quantity were used, it would dissolve the whole of that combination.

Muriatic acid is now to be poured in till the whole of the matter is dissolved. At first a flaky precipitate appears, because the acid combines with the alkali

Analysis of Minerals. which kept it in solution. Then an effervescence takes place, owing to the decomposition of some carbonat of potash formed during the fusion. At the same time the flaky precipitate is redissolved; as is also that part of the matter which, not having been dissolved in the water, had remained at the bottom of the dish in the form of a powder. This powder, if it consists only of silica and alumina, dissolves without effervescence; but if it contains lime, an effervescence takes place.

If this solution in muriatic acid be colourless, we may conclude that it contains no metallic oxide, or only a very small portion; if its colour be purplish red, it contains manganese; orange red indicates the presence of iron; and golden yellow the presence of chromium.

This solution is to be poured into a capsule of porcelain, covered with paper, and evaporated to dryness in a sand bath. When the evaporation is drawing towards its completion, the liquor assumes the form of jelly. It must then be stirred constantly with a glass or porcelain rod, in order to facilitate the disengagement of the acid and water, and to prevent one part of the matter from being too much, and another not sufficiently dried. Without this precaution, the silica and alumina would not be completely separated from each other.

³⁰⁰ **How the silica is separated.** When the matter is reduced almost to a dry powder, a large quantity of pure water is to be poured on it; and, after exposure to a slight heat, the whole is to be poured on a filter. The powder which remains upon the filter is to be washed repeatedly, till the water with which it has been washed ceases to precipitate silver from its solutions. This powder is the whole of the silica which the stone that we are analysing contained. It must first be dried between folds of blotting paper, then heated red hot in a platinum or silver crucible, and weighed while it is yet warm. It ought to be a fine powder, of a white colour, not adhering to the fingers, and entirely soluble in acids. If it be coloured, it is contaminated with some metallic oxide; and shews, that the evaporation to dryness has been performed at too high a temperature. To separate this oxide, the silica must be boiled with an acid, and then washed and dried as before. The acid solution must be added to the water which passed through the filter, and which we shall denominate A.

The watery solution A is to be evaporated till its quantity does not exceed 30 cubic inches, or nearly an English pint. A solution of carbonat of potash is then to be poured into it till no more matter precipitates. It ought to be boiled a few moments to enable all the precipitate to fall to the bottom. When the whole of the precipitate has collected at the bottom, the supernatant liquid is to be decanted off; and water being substituted in its place, the precipitate and water are to be thrown upon a filter. When the water has run off, the filter with the precipitate upon it is to be placed between folds of blotting paper. When the precipitate has acquired some consistence, it is to be carefully collected by an ivory knife, mixed with a solution of pure potash, and boiled in a porcelain capsule. If any alumina

(y) Part of this section is to be considered as an abstract of a treatise of Vauquelin on the analysis of stones, published in the *Annales de Chimie*, Vol. XXX. p. 66.

(z) Barytes has also been discovered in one single stone, the *fluorolite*; but its presence in stones is so uncommon, that it can scarcely be looked for. The method of detecting it shall be noticed afterwards.

Analysis of Minerals.

301
And the alumina,

alumina or glucina be present, they will be dissolved in the potafs; while the other substances remain untouched in the form of a powder, which we shall call B.

Into the solution of potafs as much acid must be poured as will not only saturate the potafs, but also completely redissolve any precipitate which may have at first appeared. Carbonat of ammonia is now to be added in such quantity that the liquid shall taste of it. By this addition the whole of the alumina will be precipitated in white flecks, and the glucina will remain dissolved, provided the quantity of carbonat of ammonia used be not too small. The liquid is now to be filtered, and the alumina which will remain on the filter is to be washed, dried, heated red hot, and then weighed. To see if it be really alumina, dissolve it in sulphuric acid, and add a sufficient quantity of sulphat or acetite of potafs; if it be alumina, the whole of it will be converted into crystals of alum.

302
Glucina,

Let the liquid which has passed through the filter be boiled for some time, and the glucina, if it contains any, will be precipitated in a light powder, which may be dried and weighed. When pure, it is a fine, soft, very light, tasteless powder, which does not concrete when heated, as alumina does.

303
Lime,

The residuum B may contain lime, magnesia, and one or more metallic oxides. Let it be dissolved in weak sulphuric acid, and the solution evaporated to dryness. Pour a small quantity of water on it. The water will dissolve the sulphat of magnesia, and the metallic sulphats; but the sulphat of lime will remain undissolved. Let it be heated red hot in a crucible, and weighed. The lime amounts to 0.41 of the weight.

Let the solution containing the remaining sulphats be diluted with a large quantity of water, let a small excess of acid be added, and then let a saturated carbonat of potafs be poured in. The oxides of chromum, iron, and nickel, will be precipitated, and the magnesia and oxide of manganese will remain dissolved. The precipitate we shall call C.

304
Manganese,

Into the solution let a solution of hydrosulphuret of potafs be poured, and the manganese will be precipitated in the state of a hydrosulphuret. Let it be calcined in contact with air, and weighed. The magnesia may then be precipitated by pure potafs, washed, exposed to a red heat, and then weighed.

305
Magnesia,

Let the residuum C be boiled repeatedly with nitric acid, then mixed with pure potafs; and after being heated, let the liquid be decanted off. Let the precipitate, which consists of the oxides of iron and nickel, be washed with pure water; and let this water be added to the solution of the nitric acid and potafs. That solution contains the chromum converted into an acid. Add to this solution an excess of muriatic acid, and evaporate till the liquid assumes a green colour; then add a pure alkali: The chromum precipitates in the state of an oxide, and may be dried, and weighed.

307
Iron,

Let the precipitate, consisting of the oxides of iron and nickel, be dissolved in muriatic acid; add an excess of ammonia: the oxide of iron precipitates. Let it be washed, dried, and weighed.

308
And nickel.

Evaporate the solution, and the oxide of nickel will also precipitate; and its weight may be ascertained in the same manner with the other ingredients.

The weights of all the ingredients obtained are now to be added together, and their sum-total compared with

the weight of the matter submitted to analysis. If the two are equal, or if they differ only by .03 or .04 parts, we may conclude that the analysis has been properly performed: but if the loss of weight be considerable, something or other has been lost. The analysis must therefore be repeated with all possible care. If there is still the same loss of weight, we may conclude that the stone contains some substance, which has either evaporated by the heat, or is soluble in water.

A fresh portion of the stone must therefore be broken into small pieces, and exposed in a porcelain crucible to a strong heat. If it contains water, or any other volatile substance, they will come over into the receiver; and their nature and weight may be ascertained.

If nothing comes over into the receiver, or if what comes over is not equal to the weight wanting, we may conclude that the stone contains some ingredient which is soluble in water.

To discover whether it contains potafs, let the stone, reduced to an impalpable powder, be boiled five or six times in succession, with very strong sulphuric acid, applying a pretty strong heat towards the end of the operation, in order to expel the excess of acid; but taking care that it be not strong enough to decompose the salts which have been formed.

Water is now to be poured on, and the residuum, which does not dissolve, is to be washed with water till it becomes tasteless. The watery solution is to be filtered, and evaporated to dryness, in order to drive off any excess of acid which may be present. The salts are to be again dissolved in water; and the solution, after being boiled for a few moments, is to be filtered and evaporated to a consistence proper for crystallizing. If the stone contains a sufficient quantity of alumina, and if potafs be present, crystals of alum will be formed; and the quantity of potafs may be discovered by weighing them, it being nearly $\frac{1}{10}$ th of their weight. If the stone does not contain alumina, or not in sufficient quantity, a solution of pure alumina in sulphuric acid must be added. Sometimes the alum, even when potafs is present, does not appear for several days, or even weeks; and sometimes, when a great quantity of alumina is present, if the solution has been too much concentrated by evaporation, the sulphat of alumina prevents the alum from crystallizing at all. Care, therefore, must be taken to prevent this last source of error. The alum obtained may be dissolved in water, and barytic water poured into it as long as any precipitate forms. The liquor is to be filtered, and evaporated to dryness. The residuum will consist of potafs and a little carbonat of potafs. The potafs may be dissolved in a little water. This solution, evaporated to dryness, gives us the potafs pure; which may be examined and weighed.

If no crystals of alum can be obtained, we must look for some other substance than potafs. The stone, for instance, may contain soda. The presence of this alkali may be discovered by decomposing the solution in sulphuric acid, already described, by means of ammonia. The liquid which remains is to be evaporated to dryness, and the residuum is to be calcined in a crucible. By this method, the sulphat of ammonia will be volatilized, and the soda will remain. It may be redissolved in water, crystallized, and examined.

If sulphuric acid does not attack the stone, as is often the case, it must be decomposed by fusion with soda,

Analysis of Minerals.

309
Method of detecting volatile bodies.310
Method of ascertaining whether stones contain potafs.

Analysis of Minerals.

Analysis of Minerals.

da, in the same manner as formerly directed with pot-
 as. The matter, after fusion, is to be diluted with
 water, and then saturated with sulphuric acid. The
 solution is to be evaporated to dryness, the residuum
 again dissolved in water, and evaporated. Sulphat of
 soda will crystallize first; and by a second evaporation,
 if the stone contains potash and alumina, crystals of alum
 will be deposited.

The presence of potash may be discovered, by mix-
 ing with a somewhat concentrated solution of muriat
 of platinum, the salt obtained, either by decomposing
 the stone immediately by an acid, or by saturating with
 an acid the matter obtained by fusing the stone with
 soda. If any potash be present, a very red precipitate
 will be formed. This precipitate is a triple salt, com-
 posed of potash, muriatic acid, and oxide of platinum.
 Ammonia, indeed, produces the same precipitate; but
 ammonia has not hitherto been discovered in stones.

312
Analysis of
saline
stones,

In this manner may simple stones and aggregates be
 analysed. As to saline stones, their analysis must vary
 according to the acid which they contain. But almost
 all of them may be decomposed by one or other of two
 methods; of each of which we shall give an example.

I. Analysis of Carbonat of Strontites.

313
Of Carbo-
nates,

Klaproth analysed this mineral by dissolving 100
 parts of it in diluted muriatic acid: during the solution,
 30 parts of carbonic acid escaped. The solution crys-
 tallized in needles, and when dissolved in alcohol, burnt
 with a purple flame. Therefore it contained strontites.
 He dissolved a grain of sulphat of potash in six ounces
 of water, and let fall into it three drops of the muriatic
 solution. No precipitate appeared till next day. There-
 fore the solution contained no barytes; for if it had, a
 precipitate would have appeared immediately.

He then decomposed the muriatic acid solution, by
 mixing it with carbonat of potash. Carbonat of stron-
 tites precipitated. By the application of a strong heat,
 the carbonic acid was driven off. The whole of the
 earth which remained was dissolved in water. It crys-
 tallized; and when dried, weighed $69\frac{1}{2}$.*

* Klaproth's
Beiträge, i.
260.

II. Analysis of Sulphat of Strontites.

Mr Vauquelin analysed an impure specimen of this
 mineral as follows:

314
Sulphats,

On 200 parts of the mineral, diluted nitric acid was
 poured. A violent effervescence took place, and part
 of the mineral was dissolved. The undissolved portion,
 after being heated red hot, weighed 167. Therefore
 33 parts were dissolved.

The nitric solution was evaporated to dryness: A
 reddish substance remained, which indicated the presence
 of oxide of iron. This substance was redissolved in wa-
 ter, and some ammonia mixed with it; a reddish pre-
 cipitate appeared, which, when dried, weighed 1, and
 was oxide of iron. The remainder of the solution was
 precipitated by carbonat of potash. The precipitate
 weighed, when dried, 20, and possessed the properties
 of carbonat of lime. Therefore 200 parts of this mi-
 neral contain 20 of carbonat of lime, 1 of oxide of iron,
 and the remainder of the 33 parts he concluded to be
 water.

The 167 parts, which were insoluble in nitric acid,
 were mixed with 500 parts of carbonat of potash, and
 7000 parts of water, and boiled for a considerable time.

The solution was then filtered, and the residuum wash-
 ed and dried. The liquid scarcely effervesced with
 acids; but with barytes it produced a copious precipi-
 tate, totally indissoluble in muriatic acid. Therefore it
 contained sulphuric acid.

The undissolved residuum, when dried, weighed 129
 parts. It dissolved completely in muriatic acid. The
 solution crystallized in needles; when dissolved in alco-
 hol, it burnt with a purple flame; and, in short, had all
 the properties of muriat of strontites. Therefore these
 129 parts were carbonat of strontites. Now, 100 parts
 of this carbonat contain 30 of carbonic acid; therefore
 129 contain 38.7. Therefore the mineral must con-
 tain in 200 parts 90.3 of strontites.

Now, the insoluble residuum of 167 parts was pure
 sulphat of strontites; and we have seen that it contain-
 ed 90.3 of strontites. Therefore the sulphuric acid must
 amount to 76.7 parts*.

Nearly in the same manner as in the first of these ex-
 amples, may the analysis of carbonat of lime and barytes
 be performed; and nearly in the same manner with the
 second, we may analyse the sulphats of lime and barytes.

Phosphat of lime may be dissolved in muriatic acid,
 and the lime precipitated by sulphuric acid, and its
 quantity ascertained by decomposing the sulphat of lime
 obtained. The liquid solution may be evaporated to
 the consistence of honey, mixed with charcoal powder,
 and distilled in a strong heat. By this means phospho-
 rus will be obtained. The impurities with which the
 phosphat may be contaminated will partly remain undis-
 solved, and be partly dissolved, in muriatic acid. They
 may be detected and ascertained by the rules laid down
 in the second section of this chapter.

The fluat of lime may be mixed with sulphuric acid
 and distilled. The fluoric acid will come over in the
 form of gas, and its weight may be ascertained. What
 remains in the retort, which will consist chiefly of sul-
 phat of lime, may be analysed by the rules already laid
 down.

The borat of lime may be dissolved in nitric or sul-
 phuric acid. The solution may be evaporated to dry-
 ness, and the boracic acid separated from the residuum
 by means of alcohol, which will dissolve it without act-
 ing on any of the other ingredients. The remainder
 of the dry mass may be analysed by the rules laid down
 in Sect. II. of this Chapter.

SECT. III. Of the Analysis of Combustibles.

THE only combustibles of whose analysis it will be
 necessary to speak are coals and sulphur; for the meth-
 od of analysing the diamond and oil has already been
 given in the article CHEMISTRY, Suppl.

Coal is composed of carbon, bitumen, and some por-
 tion of earth. The earths may be detected by burning
 completely a portion of the coal to be analysed. The
 ashes which remain after incineration consist of the
 earthy part. Their nature may be ascertained by the
 rules laid down in Sect. II. of this Chapter.

For the method of ascertaining the proportion of
 carbon and bitumen in coal, we are indebted to Mr Kir-
 wan.

When nitre is heated red hot, and charcoal is thrown
 on it, a violent detonation takes place; and if the quan-
 tity of charcoal be sufficient, the nitre is completely de-
 composed. Now, it requires a certain quantity of pure
 carbon men.

* Jour. de
Min. N°
xxxvii. p. I.315
Phosphats,316
Fluats,317
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rats.318
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coal how
examined.319
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detecting
the relative
proportions
of charcoal
and bitu-
men.

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Minerals.

* Mem.
Séav. E-
trang. xi.
626.

† Macquer's
Dictionary,
2d edit.
p. 481.

‡ Mineral-
ogy, ii.
522.

carbon to decompose a given weight of nitre. From the experiments of Lavoisier, it follows that, when the detonation is performed in close vessels under water, 13.21 parts of charcoal are capable of decomposing 100 parts of nitre *. But when the detonation is performed in an open crucible, a smaller proportion of charcoal is necessary, because part of the nitre is decomposed by the action of the surrounding air. Scheele found that under these circumstances 10 parts of plumbago were sufficient to decompose 96 parts of nitre, and Mr Kirwan found that nearly the same quantity of charcoal was sufficient for producing the same effect.

Macquer long ago observed, that no volatile oily matter will detonate with nitre, unless it be previously reduced to a charcoal; and that then its effect upon nitre is precisely proportional to the charcoal which it contains †. Mr Kirwan, upon trying the experiment with *vegetable pitch* and *maltha*, found that these substances did not detonate with nitre, but merely burn upon its surface with a white or yellow flame; and that after they were consumed, nearly the same quantity of charcoal was necessary to decompose the nitre which would have been required if no bitumen had been used at all ‡. Now coals are chiefly composed of charcoal and bitumen. It occurred therefore to Mr Kirwan, that the quantity of charcoal which any coal contains may be ascertained by detonating it with nitre: For since the bitumen of the coal has no effect in decomposing nitre, it is evident that the detonation and decomposition must be owing to the charcoal of the coal; and that therefore the quantity of coal necessary to decompose a given portion of nitre will indicate the quantity of carbon which it contains: and the proportion of charcoal and earth which any coal contains being ascertained, its bituminous part may be easily had from calculation.

The crucible which he used in his experiments was large: it was placed in a wind furnace at a distance from the flue, and the heat in every experiment was as equal as possible. The moment the nitre was red hot, the coal, previously reduced to small pieces of the size of a pea head, was projected in portions of one or two grains at a time, till the nitre would no longer detonate; and every experiment was repeated several times to ensure accuracy.

He found that 480 grains of nitre required 50 grains of Kilkenny coal to decompose it by this method. Therefore 10 grains would have decomposed 96 of nitre; precisely the quantity of charcoal which would have produced the same effect. Therefore Kilkenny coal is composed almost entirely of charcoal.

Cannel coal, when incinerated, left a residuum of 3.12 in the 100 parts of earthy ashes. 66.5 grains of it were required to decompose 480 grains of nitre; but 50 parts of charcoal would have been sufficient: therefore 66.5 grains of cannel coal contain 50 grains of charcoal, and 2.08 of earth; the remaining 14.42 grains must be bitumen. In this manner may the composition of any other coal be ascertained.

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Method of
analysing
sulphur.

As for sulphur, in order to ascertain any accidental impurities with which it may be contaminated, it ought to be boiled in thirty times its weight of water, afterwards in diluted muriatic acid, and lastly in diluted nitro-muriatic acid. These substances will deprive it of all its impurities without acting on the sulphur itself, at least if the proper cautions be attended to. The

sulphur may then be dried and weighed. The deficiency in weight will mark the quantity of the substances which contaminate the sulphur. The solutions may be evaporated and examined, according to the rules laid down in the second and fourth sections of this chapter.

SECT. IV. Of the Analysis of Ores.

THE method of analysing ores must vary considerably, according to the metals which they are suspected to contain. A general method, therefore, of analysing ores would be of no use, even if it could be given, because it would be too complicated ever to be practised. We shall content ourselves with exhibiting a sufficient number of the analysis of ores, to take in most of the cases which can occur. He who wishes for more information on the subject, may consult the treatise of Bergman on the *Analyses of Ores*; Mr Kirwan's treatise on the same subject; and, above all, he ought to study the numerous analyses of ores which have been published by Mr Klaproth.

I. Analysis of Red Silver Ore.

Mr Vauquelin analysed this ore as follows:

He reduced 100 parts of it to fine powder, poured over it 500 parts of nitric acid previously diluted with water, and applied a gentle heat to the mixture. The colour of the powder, which before the mixture with nitric acid was a deep purple, became gradually lighter, till at last it was pure white. During this change no nitrous gas was extricated; hence he concluded, that the metals in the ore were in the state of oxides.

When the nitric acid, even though boiled gently, did not appear to be capable of dissolving any more of the powder, it was decanted off, and the residuum, after being carefully washed, weighed 42.06.

Upon these 42.06 parts concentrated muriatic acid was poured; and by the application of heat, a considerable portion was dissolved. The residuum was repeatedly washed with muriatic acid, and then dried. Its weight was 14.6666. One portion of these 14.6666 parts, when thrown upon burning coals, burnt with a blue flame and sulphureous smell. Another portion sublimed in a close vessel without leaving any residuum. In short, they had all the properties of sulphur. Therefore 100 parts of red silver ore contain 14.6666 of sulphur.

The muriatic acid solution was now diluted with a great quantity of water; it became milky, and deposited a white flaky powder, which when washed and dried weighed 21.25. This powder, when heated with tartar in a crucible, was converted into a bluish white brittle metal, of a foliated texture, and possessing all the other properties of antimony. Red silver ore, therefore contains 21.25 of oxide of antimony.

The solution in nitric acid remained now to be examined. When muriatic acid was poured into it, a copious white precipitate appeared, which, when washed and dried, weighed 72.66. It had all the properties of muriat of silver. According to Mr Kirwan's tables, 72.66 of muriat of silver contain 60.57 of oxide of silver. Therefore red silver ore, according to this analysis, is composed of

60.57 oxide of silver,
21.25 oxide of antimony,
14.66 sulphur.
96.48

³²³ Analysis of Minerals. The loss, which amounts to 3.52 parts, is to be ascribed to unavoidable errors which attend such experiments.

II. Antimoniated Silver Ore.

³²³ Analysis of antimoniated silver ore.

Klaproth analysed this ore as follows :

On 100 parts of the ore, reduced to a fine powder, he poured diluted nitric acid, raised the mixture to a boiling heat, and after pouring off the acid, added new quantities repeatedly, till it would dissolve nothing more. The residuum was of a greyish yellow colour, and weighed, when dry, 26.

These 26 parts he digested in a mixture of nitric and muriatic acid; part was dissolved, and part still remained in the form of a powder. This residuum, when washed and dried, weighed 13 parts. It had the properties of sulphur; and when burnt, left a residuum of one part, which had the properties of filica. Antimoniated silver ore, therefore, contains, in the 100 parts, 12 parts of sulphur and 1 of filica.

When the nitro-muriatic solution was diluted with about 20 times its weight of water, a white precipitate appeared; which, when heated to redness, became yellow. Its weight was 13. No part evaporated at a red heat: therefore it contained no arsenic. On burning coals, especially when soda was added, part was reduced to a metal, having the properties of antimony; and in a pretty high heat, the whole evaporated in a grey smoke. These 13 parts were therefore oxide of antimony: They contain about 10 parts of metallic antimony; and as the state of oxide was produced by the action of the nitric acid, we may conclude that antimoniated silver ore contains 10 parts of antimony.

The nitric acid solution remained still to be examined. It was of a green colour. When a solution of common salt was poured in, a white precipitate was obtained, which possessed the properties of muriat of silver. When dried, it weighed 87.75 parts; and when reduced, 65.81 parts of pure silver were obtained from it. Antimoniated silver ore, therefore, contains 65.81 of silver.

Into the nitric acid solution, thus deprived of the silver, he dropped a little of the solution of sulphat of soda; but no precipitate appeared. Therefore it contained no lead.

He supersaturated it with pure ammonia, on which a grey precipitate appeared. When dried, it weighed 5 parts. This, on burning coals, gave out an arsenical smell. It was redissolved in nitric acid; sulphurated alkali occasioned a smutty brown precipitate; and prussic alkali a prussian blue, which, after torrefaction, was magnetic. Hence he concluded, that these five parts were a combination of iron and arsenic acid.

The nitric solution, which had been supersaturated with ammonia, was blue; he therefore suspected that it contained copper. To discover this, he saturated it with sulphuric acid, and put into it a polished plate of iron. The quantity of copper was so small, that none could be collected on the iron.

III. Grey Copper Ore.

³²⁴ Analysis of grey copper ore.

Klaproth analysed this ore as follows :

Three hundred grains of it, not completely freed from its matrix, were reduced to a fine powder; four times their weight of nitric acid was poured on them, and the

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whole was digested. The acid was then poured off, and an equal quantity again digested on the residuum. The two acid solutions were mixed together. The residuum was of a yellowish grey colour, and weighed 188 grains.

On this residuum six times its weight of muriatic acid was boiled. The residuum was washed, first with muriatic acid, and afterwards with alcohol, and the washings added to the muriatic acid solution. The residuum, when dried, weighed 105.5 grains. Part of it burned with a blue flame; and was therefore sulphur. The residuum amounted to 80.25 grains, and had the properties of filica. When melted with black flux, about $\frac{3}{4}$ ths of a grain of silver were obtained from it. Thus 300 parts of grey copper ore contain 25.25 gr. of sulphur, and 79.5 of filica.

The muriatic acid solution, which was of a light yellow colour, was concentrated by distillation, a few crystals of muriat of silver appeared in it, which contained about $\frac{1}{4}$ th grain of silver. The solution, thus concentrated, was diluted with a great quantity of water; a white precipitate was deposited, which, when dried, weighed 97.25 grains. It possessed the properties of oxide of antimony, and contained 75 grains of antimony. Therefore 300 grains of grey copper ore contain 70 of antimony.

The nitric acid solution was of a clear green colour. A solution of common salt occasioned a white precipitate, which was muriat of silver, and from which 31.5 grains of silver were obtained.

A little sulphat of potash, and afterwards sulphuric acid, were added, to see whether the solution contained lead; but no precipitate appeared.

The solution was then supersaturated with ammonia; a loose fleaky brownish red precipitate appeared, which, when heated to redness, became brownish black, and weighed 9 $\frac{1}{4}$ th grains. This precipitate was dissolved in muriatic acid; half a grain of matter remained undissolved, which was filica. The muriatic acid solution, when prussic alkali was added, afforded a blue precipitate; and soda afterwards precipitated 1.5 grains of alumina. Therefore 300 grains of grey copper ore contain 7.25 grains of iron, and 1.5 of alumina.

Into the nitric solution supersaturated with ammonia, and which was of an azure blue colour, a polished plate of iron was put: By this method 69 grains of copper were obtained.

IV. Sulphuret of Tin.

Klaproth analysed this ore as follows * :

On 120 grains of the ore reduced to powder, six times their weight of nitro-muriatic acid, composed of 2 parts of muriatic, and 1 of nitric acid, were poured. There remained undissolved 43 grains, which had the appearance of sulphur; but containing green spots, was suspected not to be pure. After a gentle combustion, 13 grains remained; 8 of which were dissolved in nitro-muriatic acid, and added to the first solution. The remaining 5 were separated by the filtre, and heated along with wax. By this method about a grain of matter was obtained, which was attracted by the magnet; and which therefore was iron. The residuum weighed 3 grains, and was a mixture of alumina and filica. Thus 120 grains of sulphuret of tin contain 30 grains of sulphur, 1 of iron, and 3 of alumina and filica.

* Observations on the Fossils of Cornwall, p. 48.
³²⁵ Analysis of sulphuret of tin.

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Analysis of
Minerals.

The nitro-muriatic solution was completely precipitated by potash. The precipitate was of a greyish green colour. It was washed and dried, and again dissolved in diluted muriatic acid. Into the solution a cylinder of pure tin was put, which weighed exactly 217 grains. The solution became gradually colourless, and a quantity of copper precipitated on the cylinder of tin, which weighed 44 grains. To see whether it was pure, a quantity of nitric acid was digested on it; the whole was dissolved, except one grain of tin. Therefore 120 grains of sulphuret of tin contains 43 grains of copper.

The cylinder of tin now weighed only 128 grains; so that 89 grains had been dissolved. Into the solution a cylinder of zinc was put; upon which a quantity of tin precipitated. When washed and dried, it weighed 130 grains. The tin he melted with tallow and powdered charcoal; and when cold, he washed off the charcoal. Among the tin globules were found some black flocculi of iron, which weighed one grain. Deducting this grain, and the 89 grains of the tin cylinder which had been dissolved, we see that the 120 grains of sulphuret of tin contained 40 grains of tin besides the grain which had been detected in the copper.

V. Plumbiferous Antimoniated Silver Ore.

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Analysis of
plumbiferous
antimoniated
silver ore.

Klaproth analysed this ore as follows:

He digested 400 grains of it, reduced to a fine powder, first in five times its weight of nitric acid, and then in twice its weight of the same acid. He then diluted this last portion of acid with eight times its weight of water, and continued the digestion. The undissolved residuum, when washed and dried, weighed 326 grains.

On this residuum he boiled muriatic acid repeatedly. The solution, on cooling, deposited acicular crystals. These he carefully separated, and put by. The undissolved residuum weighed 51 grains. It had the properties of sulphur. When burned, it left one grain of silica.

The muriatic acid solution was concentrated to half its former bulk by distillation: this made it deposit more acicular crystals. He continued the distillation as long as any crystals continued to appear. He then collected the whole of these crystals together. They had the properties of muriat of lead. When mixed with twice their weight of black flux, and heated in a crucible lined with charcoal, they yielded $160\frac{1}{8}$ grains of lead.

Sulphuret of ammonia was now added to the muriatic acid solution; an orange-coloured precipitate appeared, which shewed that the solution contained antimony. It was precipitated by a copious effusion of water, and by soda. The oxide of antimony being reduced to a mass with Spanish soap, mixed with black flux, and heated in a lined crucible, yielded 28.5 grains of antimony.

Into the nitric acid solution, obtained by the first part of the process, a solution of muriat of soda was dropped; a white precipitate was deposited, and over it acicular crystals. These crystals he dissolved, by pouring boiling water on the precipitate. The water was added to the nitric acid solution. The white precipitate was muriat of silver: when heated with twice its weight of soda, it yielded 81.5 grains of silver.

He now concentrated the nitric acid solution by eva-

poration; and then adding a solution of sulphat of soda, a white precipitate was obtained, which had the properties of sulphat of lead, and weighed 43 grains. It contained 32 grains of pure lead.

He now poured ammonia into the solution; a pale brown precipitate was obtained, which weighed 40 grains, and which appeared to consist of oxide of iron and alumina. He redissolved it in nitric acid, precipitated the iron by prussic alkali, and the alumina by soda. The alumina, after being heated to redness, weighed 28 grains; consequently the oxide of iron was 12 grains, which is equivalent to 9 grains of iron.

VI. Molybdat of Lead.

Mr Hatchett analysed this ore as follows*:

On 250 grains of the ore, reduced to a fine powder, he poured an ounce of strong sulphuric acid, and digested the mixture in a strong heat for an hour. When the solution was cool, and had settled, he decanted it off, and washed the undissolved powder with pure water, till it came away tasteless. This operation was repeated twice more; so that three ounces of sulphuric acid were used. All these solutions were mixed together, and filtered.

Four ounces of a solution of carbonat of soda were poured upon the powder which remained undissolved, and which consisted of sulphat of lead. The mixture was boiled for an hour, and then poured off. The powder was then washed, and diluted nitric acid poured on it: The whole was dissolved, except a little white powder, which, when washed, and dried on a filter by the heat of boiling water, weighed seven-tenths of a grain. It possessed the properties of silica.

The nitric acid solution was saturated with pure soda; a white precipitate was obtained, which, when washed, and dried for an hour in a heat rather below redness, weighed 146 grains. It possessed the properties of oxide of lead.

To see whether this oxide of lead contained any iron, it was dissolved in diluted nitric acid, and the lead precipitated by sulphuric acid. The solution was then saturated with ammonia; a brown powder precipitated, which, when dried, weighed one grain, and had the properties of oxide of iron.

The sulphuric acid solution was of a pale blue colour: It was diluted with 16 times its weight of pure water, and then saturated with ammonia. It became of a deep blue colour, and appeared turbid. In 24 hours a pale yellow precipitate subsided, which, when collected on a filter, and dried by a boiling water heat, weighed 4.2 grains. Its colour was yellowish brown. Muriatic acid dissolved it, and prussiat of potash precipitated it from its solution in the state of prussian blue. It was therefore oxide of iron.

The sulphuric acid solution, saturated with ammonia, was gradually evaporated to a dry salt. This salt was a mixture of molybdat of ammonia and sulphat of ammonia. A strong heat was applied, and the distillation continued till the whole of the sulphat of ammonia was driven off; and to be certain that this was the case, the fire was raised till the retort became red hot. The residuum in the retort was a black blistered mass; three ounces of nitric acid, diluted with water, were poured upon it, and distilled off. The operation was again repeated.

* Phil.

Transf.

lxxxvi. 320.

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Analysis of

molybdat

of lead.

^{Analysis of Minerals.} peated. By this method the oxide of molybdenum was converted into a yellow powder, which was yellow acid of molybdenum. It weighed 95 grains.

VII. Grey Ore of Manganese.

^{* Jour. de Min. N^o xvii. p. 12.} Mr Vauquelin analysed this ore as follows *.
³¹⁸ ^{Analysis of grey ore of manganese.} When 200 grains of it were exposed to a strong heat in a retort, there came over 10 grains of water, and 18 cubic inches of oxygen gas, mixed with a little carbonic acid gas. The mineral now weighed only 176 grains. Therefore the weight of the gas was 14 grains.

On 200 grains of the same mineral muriatic acid was poured, and heat applied. 75 cubic inches of oxy-muriatic acid gas came over, which, though mixed with some carbonic acid gas, enflamed metals when reduced to powder. When no more gas came over, the residuum was boiled. The whole was dissolved except a white powder, which weighed 12 grains, and which possessed the properties of silica.

Carbonat of potash was poured into the solution; a white precipitate was obtained, which became black by exposure to the air, and weighed 288 grains. Strong nitric acid was boiled on it repeatedly to dryness. It became of a deep black colour, and, when well washed with water and dried, weighed 164 grains. This powder was black oxide of manganese.

To see whether it contained iron, nitric acid, with a little sugar, was poured upon it, and digested on it. The acid dissolved it completely. Therefore no oxide of iron was present.

Into the water with which the black oxide of manganese had been washed, carbonat of potash was poured; a white powder precipitated, which, when dried, weighed 149 grains, and which possessed the properties of carbonat of lime.

VIII. Wolfram.

³²⁹ ^{Analysis of wolfram.} Messrs Vauquelin and Hecht analysed this mineral as follows:

On 200 parts of Wolfram in powder, three times its weight of muriatic acid were poured, and the mixture boiled for a quarter of an hour: a yellow powder appeared, and the solution was of a brown colour. The acid was allowed to cool, and then carefully decanted off, and the residuum washed. The residuum was then digested for some hours with ammonia, which dissolved a part of it. The residuum was washed, and new muriatic acid again poured over it; then the residuum was digested with ammonia, as before: and the operation was continued till the whole wolfram was dissolved.

All the ammoniacal solutions being joined together, were evaporated to dryness, and the salt which remained was calcined: a yellow powder was obtained; it weighed 134 grains, and was yellow acid of tungsten.

Into the muriatic acid solutions, which were all mixed together, a sufficient quantity of sulphuric acid was poured to decompose all the salts. The solution was then evaporated to dryness; and the salts which were obtained by this evaporation were redissolved in water.

^{Analysis of Minerals.} A white powder remained, which weighed three grains, and which possessed the properties of silica.

The excess of acid of the solution was saturated with carbonat of potash; the liquor became brown, but nothing precipitated. When boiled, a red powder precipitated, and the brown colour disappeared. The addition of more carbonat of potash caused a farther precipitation of a yellowish powder. This precipitate consisted of the oxides of iron and manganese combined. Nitric acid was distilled off it repeatedly; it was then boiled in acetic acid. The acetic solution was precipitated by potash. Nitric acid was again distilled off it, and it was again boiled in acetic acid. This process was repeated till nitric acid produced no further change. The different powders which could not be dissolved in the acetic acid were collected, mixed with a little oil, and heated red hot. The powder became black, and was attracted by the magnet. It was therefore oxide of iron. It weighed 36 grains.

The acetic solution contained the oxide of manganese: It was precipitated by an alkali, and, when dried, weighed 12.5 grains.

IX. Oxide of Titanium and Iron.

Vauquelin analysed this ore as follows:

³³⁰ ^{Analysis of oxide of titanium and iron.} A hundred parts of the ore, reduced to a fine powder, and mixed with 400 parts of potash, were melted in a silver crucible for an hour and a half. When cool, the mixture was diluted with water; a powder remained of a brick red colour, which when washed and dried weighed 124 parts.

The watery solution had a fine green colour; when an excess of muriatic acid was added, it became red. By evaporation the liquor lost its colour. When evaporated to dryness, a salt remained, which was totally dissolved by water. From this solution carbonat of potash precipitated two parts, which had the properties of oxide of manganese.

The 124 parts of residuum were boiled in a solution of pure potash for an hour. The solution was saturated with an acid, filtered, and carbonat of potash added, which precipitated three parts. These had the properties of oxide of titanium.

The remainder of the 124 parts of residuum, which still was undissolved, was boiled with diluted muriatic acid. The liquor became yellow, and deposited 46 parts of a white powder, with a tint of red. This powder was soluble in sulphuric and muriatic acids: from these solutions, it was precipitated of a brick red colour by the infusion of nut-galls; of a green colour by sulphuret of ammonia and prussiat of potash; and of a white colour by carbonat of potash and pure ammonia. A rod of tin made these solutions red; a rod of zinc made them violet. These 46 parts therefore are oxide of titanium.

The muriatic solution, from which these 46 parts were deposited, formed, with prussiat of potash, a prussian blue; and ammonia precipitated from it 50 parts, which had the properties of yellow oxide of iron.

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M I R

Mirabeau. MIRABEAU (Honoré Gabriel, Comte de), well known both by his writings and the active part which he took in bringing about the French revolution, was born in 1749 of a noble family. Throughout life he displayed a spirit averse from every restraint, and was one of those unhappy geniuses in whom the most brilliant talents serve only as a scourge to themselves and all around them. It is told by his democratical panegyrists, as a wonderful proof of family tyranny under the old government, that not less than 67 *lettres de cachet* had been obtained by Mirabeau the father against this son and others of his relatives. This story, if true, proves, with at least equal force, what many anecdotes confirm, that, for his share of them, the son was not less indebted to his own ungovernable disposition than to the severity of his parent. He was indeed a monster of wickedness. Debauchery, gaming, impiety, and every kind of sensuality, were not enough for him. He was destitute of decency in his vices; and to supply his expences, scrupled not to perform tricks which would disgrace a thief-catcher. His father and mother disapproving, commenced a process of separation; when Mirabeau, just liberated from prison for a gross misdemeanor, was in want of money. He went to his father, sided with him against his mother, on whom he poured a torrent of invectives; and, for 100 guineas, wrote his

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father's memorial for the court. He then went to his mother; and by a similar conduct got the same sum from her; and both memorials were presented. That the father of such a man should frequently get him shut up in prison, can excite no surprise; for confinement only could withhold him from the perpetration of crimes.

The talents of Mirabeau led him frequently to employ his pen; and his publications form the chief epochs of his life. His first publication was, 1. *Essai sur le Despotisme*, "An Essay on Despotism," in 8vo. Next, in one of his confinements, he wrote, 2. a work in two vols 8vo, *On Lettres de Cachet*. 3. *Considerations sur l'Ordre de Cincinnatus*, 8vo. A remonstrance against the order of Cincinnatus, proposed at one time to be established in America. The public opinion in America favoured this remonstrance, and it proved effectual. 4. His next work was in favour of the Dutch, when Joseph II. demanded the opening of the Sheldt, in behalf of the Brabançons. It is entitled, *Doutes sur la Liberté de l'Escant*, 8vo. 5. *Lettre à l'Empereur Joseph II. sur son Règlement concernant l'Emigration*; a pamphlet of forty pages, in 8vo. 6. *De la Caisse d'Escompte*; a volume in 8vo, written against that establishment. 7. *De la Banque d'Espagne*, 8vo; a remonstrance against establishing a French bank in Spain. A controversy

Mirabeau.

Mirabeau. controversy arising upon this subject, he wrote again upon it. 8. Two pamphlets on the monopoly of the water company in Paris.

Soon after the publication of these works, he was sent in a public character to the court of Berlin; where he conducted the king's affairs just as he had formerly done those of his father and mother, fully ready to sacrifice all parties, and to sell himself to the highest bidder. With such a disposition, he could not long avoid the notice of the Prussian illuminées; and Nicolai Biesler, Gedicke, and Leuchsenring, soon became his constant companions. At Brunswick he met with Mauvillon, the worthy disciple of Philo Knigg, and at that time a professor in the Caroline college. This was the man who initiated the profligate Marquis in the last mysteries of illuminism.

Mirabeau was still at Berlin when Frederick II. died. That monarch, as is well known, was a naturalist, who, holding this life for his all, encouraged the propagation of infidelity in his dominions, from which resulted the very worst consequences to the peace of society. Of this truth his successor Frederick William was duly sensible; and determined to support the church establishment in the most peremptory manner, consistent with the principles of religious toleration. He published, therefore, soon after his accession, an edict on religion, which is a model worthy of imitation in every country; but it was attacked with the greatest virulence in numberless publications. It was called an unjustifiable tyranny over the consciences of men; the dogmas supported by it were termed absurd superstitions; the king's private character and his religious opinions were ridiculed and scandalously abused. The most daring of these attacks was a collection of anonymous letters on the constitution of the Prussian states, universally believed to be the composition of Mirabeau, who certainly wrote a French translation, with a preface and notes more impudent than the work itself. The monarch is declared to be a tyrant; the people of the Prussian dominions are addressed as a parcel of tame wretches, crouching under oppression; and the inhabitants of Silesia, represented as still in a worse condition, are repeatedly called upon to rouse themselves, and assert their rights.

About this time he published, 9. *An Essai sur le Secte des Illuminés*; one of the strangest and most impudent books that ever appeared. In it he describes a sect existing in Germany, called the *Illuminated*; and says, that they are the most absurd and gross fanatics imaginable, waging war with every appearance of reason, and maintaining the most ridiculous superstitions. He gives some account of these, and of their rituals and ceremonies, as if he had seen them all; yet no such society as he describes ever existed: and Mirabeau employed his powers of deception, merely to screen from observation the real *illuminati*, by holding out to the rulers of states this *ignis fatuus* of his own brain. For a while the essay certainly contributed to blind the eyes of the German princes; and Nicolai, with others of the junto, adopting the whim, called Mirabeau's fanatics *Obscuranten*, and joined with him in placing on the list of *Obscuranten* several persons whom they wished to make ridiculous.

Long before his initiation in the mysteries of illuminism, Mirabeau had been acquainted with all the re-

volutionary powers of the masonic lodges; nor did he, when initiated, undervalue those which flowed, or might flow, from Weishaupt's inventive genius. On his return to France, he began to introduce the new mysteries among some of his masonic brethren. His first associate was the Abbe Talleyrand de Perigord, who had already begun to act the part of Judas in the first order of the church. But to have only introduced the mysteries was not sufficient for the Marquis; he would have teachers come from Germany, who were better versed than he was in the illuminizing arts. Well acquainted with the reasons that had induced the chiefs of the order to defer the conversion of France, he found means to convince them, that the time was now come for the accomplishment of their views; and at his request a deputation was sent by Spartacus to illuminate that great kingdom. See *ILLUMINATI*, n° 40, 41, *Suppl.*

When the assembly of Notables was convened at Paris, Mirabeau foretold that it would soon be followed by a meeting of the States; and at that period he published a volume against the stockjobbing, then carried to a great height, intitled, 10. *Denonciation de l'agiotage au Roi, et à l'Assemblée de Notables*, 8vo. A *lettre de cachet* was issued against him in consequence of this publication; but he eluded pursuit, and published a pamphlet as a sequel to the book. His next work was against M. Necker, 11. *Lettre à M. de Cretelle, sur l'Administration de M. Necker*, a pamphlet in 8vo. 12. A volume in 8vo, against the Stadtholdership: *Aux Bataves, sur le Stadthouderat*. 13. *Observations sur la maison de force appelé Bicetre*, an 8vo pamphlet. 14. Another tract, intitled, *Conseils à un jeune Prince qui sent la nécessité de refaire son éducation*. 15. He now proceeded to a larger and more arduous work than any he had yet published, on the Prussian monarchy under Frederick the Great: *De la Monarchie Prussienne sous Frederic le Grand*, 4 vols, 4to, or eight in 8vo. In this work he undertakes to define precisely how a monarchy should be constituted. When the orders were issued for convening the States-general, Mirabeau returned into Provence; and at the same time published, 16. *Histoire Secrète de la Cour de Berlin*, two volumes of letters on the Secret History of the Court of Berlin. This work was condemned by the parliament of Paris, for the unreserved manner in which it delivered the characters of many foreign princes. As the elections proceeded, he offered himself a candidate in his own order at Aix; but he was so abhorred by the noblesse, that they not only rejected him, but even drove him from their presence. This affront settled his measures, and he determined on their ruin. He went to the commons, disclaimed his being a gentleman, set up a little shop in the market-place of Aix, where he sold trifles; and now fully resolved what line he should pursue, he courted the commons, by joining in all their excesses against the noblesse, and was at last returned a member of the assembly.

In consequence of this, he went to Paris; where the part he took was active, and such as tended, in general, to accelerate all the violences of the revolution. He now published, periodically, 17. his *Lettres à ses Concitoyens*, Letters to his Constituents, which form, when collected, 5 vols 8vo. It is supposed, that the fatal measure of the junction of the three orders into one national

Mirabeau,
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tional assembly, was greatly promoted by these letters. The public events of these times, and the part taken in them by Mirabeau, are the subject of general history. He lived to see the constitution of 1789 established, but not to see its consequences—the destruction of the monarchy, the death of the king, and the ruin of all property! He was accused, as well as the duke of Orleans, of hiring the mob which attacked Versailles on the 5th and 6th of October 1789; but with him was also acquitted by the tribunal of the Châtelet. The domination of his eloquence in the National Assembly had long been absolute, and, on the 29th of January 1791, he was elected president. At the latter end of March, in the same year, he was seized by a fever, and died on the 2d of April.

The talents of Mirabeau will not be doubted, though they were certainly rather brilliant than profound. To be noticed, and to lead, were the sole objects of his ambition; and for the attainment of them, he took the side of the discontented, as the best field for his matchless eloquence. Yet there was no man more devoted to the principles of a court than this Marquis, provided he could have a share in the administration; and a share he would have obtained, if any thing moderate would have satisfied him: But he thought nothing worthy of him but a place of active trust, and a high department; stations which all knew him not qualified to fill. Wanting knowledge of great things, he was learned only in the bustling detail of intrigue, and would, at any time, have sacrificed his dearest friend, and the interests of his country, for an opportunity of exercising his brilliant eloquence, and indulging his propensity to satire and lampoon. But the greatest obstacle to his advancement under the old government was the abject worthlessness of his character. Drinking was the only vice in which he did not indulge; and from this he was restrained by his exhausted constitution. To his brother, the Viscount, who was frequently intoxicated, the Marquis one day said, “How can you, brother, so expose yourself? “What (replied the Viscount)! how insatiable are you? Nature has given you every vice; and having left me only this one, you grudge it me!

MISTRAL, the name of a wind, which is mentioned in almost every account that we have of Provence, and which is remarkable for blowing almost the whole year from north-west or west-north-west, in a climate where the wind should be variable. It is said to contribute to the salubrity of the air, by dispersing the exhalations of the marshes and stagnant waters, so common in the south of Languedoc and Provence; but at times it is also very injurious, or at least very troublesome. It is not, however, on either of these accounts that it is introduced into this Work, but for the sake of the causes assigned by Saussure for its constancy, which may be applied to other winds that nearly resemble it; and which he found might be reduced to three.

“The first and most effectual cause (he says) is the situation of the Gulf of Lyons, the banks of which are the principal theatre of its ravages. This Gulf, in fact, is situated at the bottom of a funnel, formed by the Alps and Pyrenees. All the winds blowing from any point between west and north, are forced by these mountains to unite in the Gulf. Thus, winds which would not have prevailed but at one extremity of the

Gulf, or even much beyond it, are obliged to take this route, after having undergone the repercussion of these mountains; and the middle of the Gulf, instead of the calm which it might have enjoyed, is exposed to the united efforts of two streams of wind, descending in different directions. Hence arise those whirlwinds which seem to characterise the mistral, and appear to have induced the ancients to call it *Circius*, à *turbine ejus ac vertigine*. See *Aul. Gellius*, l. ii. cap. 22.

“The second cause is, the general slope of the grounds, descending from all sides towards the Gulf; which becoming all at once lower and more southerly than the lands extending behind it, is, from these joint circumstances, rendered the hottest point of all the adjacent country: and, as the air on the surface of the earth always tends from the colder to the warmer regions, the Gulf of Lyons is actually the centre towards which the air from all colder points between east and west must press. This cause, then, alone would be productive of winds directed to the Gulf, even if the repercussion of the mountains did not exert its influence.

“Finally, it is well known, that in all gulfs the landwinds blow more forcibly than opposite to plains and promontories, whatever be the situation of those gulfs. I apprehend, indeed, on strict examination (says our author), that this cause is blended with the preceding; but as the fact is generally admitted, and in some cases can be explained only by reasons drawn from the effects of heat, it may not improperly, perhaps, be distinctly mentioned. It is, at least, necessary to suppose, that several causes produce the mistral, in order to understand why, notwithstanding the variableness of the seasons and temperatures, that wind is so singularly constant in Lower Languedoc and Lower Provence. A very remarkable instance of this constancy is recorded by the Abbé Papon, in his *Voyage de Provence*, tom. ii. p. 81. He asserts, that during the years 1769 and 1770, the mistral continued for fourteen months successively. But the three causes which I have stated, taken separately, will explain its frequency, and, united, will account for its force.”

MIXT' ANGLE, or *Figure*, is one contained by both right and curved lines.

MIXT Number, is one that is partly an integer and partly a fraction; as $3\frac{1}{2}$.

MIXT Ratio, or *Proportion*, is when the sum of the antecedent and consequent is compared with the difference of the antecedent and consequent;

$$\begin{array}{l} \text{as if } \left\{ \begin{array}{l} 4 : 3 :: 12 : 9 \\ a : b :: c : d \end{array} \right. \\ \text{then } \left\{ \begin{array}{l} 7 : 1 :: 21 : 3 \\ a + b : a - b :: c + d : c - d \end{array} \right. \end{array}$$

MOCASSIMAH, in Bengal, revenue settled by a division of the produce.

MOCHULKAH, bond or obligation.

MERIS, a lake in EGYPT, occasionally mentioned in that article (*Encycl.*), and generally supposed the production of human art. Of this, however, Mr Brown says it bears no mark. “The shape, as far as was distinguishable, seems not inaccurately laid down in D’Anville’s map, unless it be, that the end nearest the Nile should run more in a north-west and south-east direction. The length may probably be between 30 and 40 miles; the breadth, at the widest part he could gain, was 5000 toises, as taken with a sextant; that is, nearly

Mistral
||
Meris.

Mofuffel
Mola.

ly six miles. The utmost possible extent of circuit must of course be 30 leagues. On the north-east and south is a rocky ridge, in every appearance primeval. In short, nothing can present an appearance more unlike the works of men. Several fishermen, in miserable boats, are constantly employed on the lake. The water is brackish, like most bodies of water under the same circumstances. It is, in the language of the country, *Birket-el-keran*, probably from its extremities bearing some resemblance to horns.

MOFUSSEL, a relative term, signifying the subordinate lands or districts, opposed to *Sudder*, which is the head.

MOHACZ, *MOHATZ*, or *Mohoz*, a town in the Lower Hungary, upon the Danube, between the river Sarwizu to the north, and the Drave to the south; four German miles from either, six from Esseck to the north, and nine from Colocoa to the south. This otherwise small place is memorable for two great battles here fought; the first between Lewis king of Hungary and Solyman the Magnificent, in 1526: in which that unfortunate Prince Lewis (being about 20 years old), with 25,000 men, fought 300,000 Turks; when, being overpowered by numbers, 22,000 of the Christian army were slain upon the place; 5000 waggons, eighty great cannon, 600 small ones, with all their tents and baggage, were taken by the victors; and the King, in his flight over the brook Curafs, fell into a quagmire, and was swallowed up. After which, Solyman took and slew 200,000 Hungarians, and got such a footing in that kingdom, that he could never be expelled. This fatal battle was fought October 29. The second, in some part, retrieves the loss and infamy of the former. The Duke of Loraine being sent by the Emperor, with express orders to pass the Drave and take Esseck, his highness, July 10, 1687, with great difficulty passed that river, then extremely swelled with rains; but finding the Prime Visier encamped at Esseck, with an army of 100,000 men, so strongly, that it was not possible to attack him in that post without the ruin of the Christian army, he retreated, and repassed it the 23d of the same month; where, upon the 29th, the Prime Visier passed that river at Esseck; and upon August 12th, there followed a bloody fight, in which the Turks lost 100 pieces of cannon, 12 mortars, all their ammunition, provision, tents, baggage, and treasure, and about 8000 men upon the place of battle, besides what were drowned in passing the river, which could never be known. After which victory, General Dunewalt, September 30th, found Esseck totally deserted by the Turks, and took possession of it.

MOHER, in Bengal, a gold coin, worth about 33 shillings.

MOHERIR, a writer of accounts.

MOINEAU, a flat bastion raised before a curtain when it is too long, and the bastions of the angles too remote to be able to defend one another. Sometimes the moineau is joined to the curtain, and sometimes it is divided from it by a moat. Here musquetry are placed to fire each way.

MOLE (See *TALPA*, *Encycl.*), is an animal exceedingly troublesome, both to gardeners and farmers; and there are persons who contrive to make a livelihood by the trade of *mole-catching*. These men, it is well known, are generally quacks and cheats; and the secrets which

they sell for extirpating those destructive animals are of very little avail. Even poison seldom produces any considerable effect; because the mole, while it does not drink, lives only on roots and worms. Under the word *MOLE* (*Encycl.*), some directions will be found for clearing fields of this destructive animal; but the following are perhaps preferable, as they seem to have been the result of much experience:

Immediately at day-break, it will be necessary to make a tour round the garden or meadow, from which it is wished to extirpate the moles; for at that time they will be all found at work, as may be seen by the hills newly thrown up. If the person is then close to the hill, he must proceed as the gardeners do, and turn up with a stroke of the spade the hill together with the digger. The passage is then cut through before the animal is aware of the attack; and therefore it has not power to escape. If the mole-hill be fresh, even though the animal may not be throwing up earth, the person ought not to lose his time in waiting, but should immediately proceed to the operation above-mentioned.

If you find a fresh hill standing by itself, which seems to shew by its situation that it has no communication with any other, which is always the case when the mole has worked from the surface downwards in endeavouring to procure a more convenient habitation, after the hill has been turned up with the spade, a bucket of water should be poured over the mouth of the passage. By these means the animal, which is at no great distance, will be obliged to come forth, and may be easily caught with the hand.

You may discover also whether a hill has any communication with another, if you apply your ear to it, and then cough or make a loud noise. If it has no communication with the neighbouring hills, you will hear the terrified animal make a noise by its motion. It will then be impossible for it to escape; and you may either pour water into the hole, or turn up the hill with a spade, until the mole is found; for, in general, it never goes deeper into the earth than from fifteen to eighteen inches.

When any of the beds in a garden have been newly watered, the mole, attracted by the coolness and moisture, readily repairs thither, and takes up its residence in them, making a passage at the depth of scarcely an inch below the surface. In that case it may easily be caught. When you see it at work, you need only tread behind the animal with your feet on the passage to prevent its retreat, and then turn up the hill with a spade; by which means you will be sure to catch it.

When you dig after it with a spade, the animal forces its way downwards into the earth in a perpendicular direction, in order that it may the better escape the threatened danger. In that case it will not be necessary to dig long, but to pour water over the place, which will soon make the animal return upwards.

People, in general, are not aware of the great mischief occasioned in fields and gardens by these animals. We are, however, informed by Buffon, that in the year 1740 he planted fifteen or sixteen acres of land with acorns, and that the greater part of them were in a little time carried away by the moles to their subterranean retreats. In many of these there were found half a bushel, and in others a bushel. Buffon, after this circumstance, caused a great number of iron traps to be constructed;

